Clemson University
3 1604 011 399 344

Digitized by the Internet Archive
in 2013

http://archive.org/details/mineralresources011913

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

MINERAL RESOURCES

OF THE

UNITED STATES

CALENDAR YEAR

1913

PART I—METALS

Clemson College Library
Government Publications

WASHINGTON
GOVERNMENT PRINTING OFFICE
1914

CONTENTS.

Page.

Mineral products of the United States: Review of conditions and output in 1912 and 1913, by E. W. Parker VII
Summary of the mineral production of the United States in 1913, by W. T. Thom CXXVII
Prefatory note to the general and mines reports on gold, silver, copper, lead, and zinc, by H. D. McCaskey CLXXI
Bauxite and aluminum, by W. C. Phalen 1
Chromic iron ore, by J. S. Diller 29
Gold, silver, copper, lead, and zinc in South Dakota and Wyoming, by C. W. Henderson 41
Manganese and manganiferous ores, by D. F. Hewett 57
Recovery of secondary metals, by J. P. Dunlop 75
Silver, copper, lead, and zinc in the Central States, by B. S. Butler and J. P. Dunlop 81
- Introduction, by J. P. Dunlop 81
  - Arkansas, by J. P. Dunlop 86
  - Illinois, by J. P. Dunlop 90
  - Iowa, by J. P. Dunlop 95
  - Kansas, by J. P. Dunlop 97
  - Kentucky, by J. P. Dunlop 102
  - Michigan, by B. S. Butler 104
  - Missouri, by J. P. Dunlop 115
  - Oklahoma, by J. P. Dunlop 152
  - Wisconsin, by J. P. Dunlop 160

Gold, silver, copper, lead, and zinc in the Eastern States, by H. D. McCaskey 173
- Introduction 173
  - Alabama 178
  - Georgia 180
  - Maine 183
  - Maryland 183
  - Massachusetts 183
  - New Hampshire 183
  - New Jersey 183
  - New York 184
  - North Carolina 184
  - Pennsylvania 188
  - South Carolina 188
  - Tennessee 189
  - Vermont 192
  - Virginia 192

Quicksilver, by H. D. McCaskey 197
Gold, silver, and copper in Alaska, by Alfred H. Brooks 213
Gold, silver, copper, lead, and zinc in Colorado, by C. W. Henderson 227
Antimony, by Frank L. Hess 279
Arsenic, by Frank L. Hess 283
Bismuth, by Frank L. Hess 285
Selenium and tellurium, by Frank L. Hess 289
Iron ore, pig iron, and steel, by E. F. Burchard 291
- Iron-ore industry in the United States 293
  - Iron ore mined and marketed, by States 297
  - Total production of iron ore 300
  - Lake Superior district 308
- Foreign trade in iron ore 314

Iron ore, pig iron, and steel, by E. F. Burchard—Continued. Page.
Iron and steel industry of the United States ... 318
Marketed production of pig iron, by States ... 320
Ferro-alloys ... 328
Production of steel ... 330
Cobalt, by Frank L. Hess ... 339
Molybdenum, by Frank L. Hess ... 341
Nickel, by Frank L. Hess ... 343
Tin, by Frank L. Hess ... 347
Titanium, by Frank L. Hess ... 351
Tungsten, by Frank L. Hess ... 353
Radium, uranium, and vanadium, by Frank L. Hess ... 363
Gold, silver, copper, lead, and zinc, in Utah, by V. C. Heikes ... 365
Gold, silver, copper, lead, and zinc in New Mexico and Texas, by C. W. Henderson ... 415
Platinum and allied metals, by David T. Day ... 445
Gold, silver, copper, lead, and zinc in California and Oregon, by C. G. Yale ... 459
Copper, by B. S. Butler ... 523
General conditions of the industry ... 524
Production ... 527
Stocks ... 576
Imports and exports ... 576
Consumption ... 578
World's production ... 581
Gold, silver, copper, lead, and zinc in Montana, by V. C. Heikes ... 583
Zinc, by C. E. Siebenthal ... 621
State of zinc industry in 1913 ... 622
Production ... 622
Resources ... 631
Metallurgy ... 639
World's production ... 646
Consumption ... 658
Prices and value ... 660
Gold, silver, copper, lead, and zinc in Arizona, by V. C. Heikes ... 673
Lead, by C. E. Siebenthal ... 709
State of lead industry in 1913 ... 709
Production ... 710
Resources ... 720
Metallurgy ... 726
World's production ... 728
Consumption ... 738
Prices and value ... 740
Metals and metallic ores in 1912 and 1913, by J. P. Dunlop ... 747
Gold, silver, copper, lead, and zinc in Idaho and Washington, by C. N. Gerry ... 755
Gold, silver, copper, lead, and zinc in Nevada, by V. C. Heikes ... 803
Gold and silver, by H. D. McCaskey ... 845
Production in 1913 ... 845
World's production of gold ... 847
Production of gold and silver since 1792 ... 849
Imports and exports ... 850
Mines report ... 851
Production reported from the mines ... 854
Mine production, by States ... 855
Distribution of production of gold and silver according to methods of treatment ... 877
Percentage of output of gold and silver by processes ... 882
Index ... 887

ILLUSTRATIONS.

		Page.
FIGURE A.	Curve showing value of mineral production of the United States, 1880–1913	CLXV
1.	Curve showing price at New York City, by months, 1910–1913, of metallic aluminum in the form of ingots	20
2.	Map showing chromic iron ore localities in Shasta County, Cal.	34
3.	Section of Brown's chromic iron ore mine, Shasta County, Cal.	35
4.	Curve showing production of iron ore, pig iron, and steel in the United States, 1870–1913	292
5.	Curve showing production of coke and anthracite pig iron in the United States from October, 1907, to December, 1913, by months.	323
6.	Curve showing prices of basic pig iron, 1907–1913	326
7.	Average weekly price of spelter at London and St. Louis, 1912–13	662
8.	Average weekly price of lead at New York and London, 1912–13	743

INSERT.

Mineral products of the United States, 1904 to 1913 ..... In pocket.

MINERAL RESOURCES OF THE UNITED STATES IN 1913—PART I.

MINERAL PRODUCTS OF THE UNITED STATES: REVIEW OF CONDITIONS AND OUTPUT IN 1912 AND 1913.

By Edward W. Parker.

INTRODUCTION.

With the present report, which covers primarily the calendar year 1913, the statistical division of the United States Geological Survey completes its thirty-second year. The initial authorization for this now important feature of the Survey's activities was contained in a provision inserted in the act of Congress making appropriations for the fiscal year 1883, that not to exceed $10,000 of the amount appropriated for the Geological Survey, might, under the direction of the Secretary of the Interior, be applied "to the procuring of statistics in relation to mines and quarries other than gold and silver and in making chemical analyses of iron, coal, and oil." The exemption of gold and silver at that time from the statistical work of the Survey was made because the production of those metals was reported on by the Director of the Mint.

With the small allotment available when the work was begun, it was possible to include in the reports (the first one of which covered the calendar year 1882) only statistical estimates prepared by experts on the several subjects, more or less extended reviews of market conditions and prices, and some special contributions on mining localities, mining methods, and technical progress. This method prevailed for the greater part of a decade. In 1889 the statistics of mineral production were compiled through a cooperating arrangement between the Survey and the Census Office, as a result of which complete lists of mining operations were obtained. These lists have been kept up to date by the Geological Survey, and the statistical history as presented in the volumes of Mineral Resources from 1889 to the present time has been the result of annual censuses of the mining industry, though many of the chapters during the next ten years continued to be prepared on contract by experts outside of the Survey organization. In the meantime, however, the work in the division of geology had developed specialists within the organization and for the last 10 years the reports on the several mineral products have been prepared by Survey geologists who have given particular study to the subjects assigned to them. This change has per-

mitted a more satisfactory compliance with the organic act of the Survey which provides that this bureau shall have charge of the "classification of the public lands and examination of the geological structure, mineral resources, and products of the public domain." As the work developed in scope and usefulness it became apparent that in the study of our mineral resources it was necessary to have more accurate knowledge of the sources from which the supply of gold and silver was obtained and in 1900 the Director of the Geological Survey was authorized to collect the mine statistics of gold and silver production, supplementing but not duplicating the work of the Director of the Mint. Since that time the statistics of gold and silver production as published have been the result of cooperative work with the Bureau of the Mint, the Survey being responsible for the statements of distribution by States, districts, and counties, and as to the character of the ores or deposits from which the metals were derived.

The statistical treatment has been developed to a high degree of accuracy, in addition to which the chapters on the different subjects have been enriched by studies of the sources of the mineral production and of the application of the products to the use of man. It is recognized than an accurate knowledge of nature's storehouses from which future supplies may be drawn is as essential as the record of past achievement, and the assembling and dissemination of information of this character has been in recent years, and will continue to be, an important feature of these reports.

An instance of the more comprehensive study of the sources of mineral wealth is given in the report on the production of iron ore in 1908, which contains maps and a brief description of the iron-producing districts and the location of the blast furnaces. A map showing the geographic distribution of the production of the precious and semiprecious metals in the Western States was published in the report for 1907, and the report on the production of coal in 1910 contains maps of the coal areas by States and groups of States, with brief descriptions of the areas themselves. Maps showing the cement localities have also been published, and current with the present report is published a wall map showing the developed petroleum and natural-gas fields of the United States. The present report completes a series of maps showing the distribution of the quarrying operations, the various stones, marble, granite, sandstone, etc., being indicated by different symbols. The first of the series, published in the report for 1911, showed by maps the quarry locations in the Eastern States. The report for 1912 contained maps giving similar information for the Central States, and maps accompanying the present report show the distribution of the quarrying industries in the Rocky Mountain and Pacific coast States. The present report also contains maps showing the borax and magnesite localities in California, the only State from which these mineral products are obtained.

The value of the mineral products of the United States now exceeds $2,000,000,000 a year. When compared with the value of the agricultural products this sum, vast as it is, appears relatively small. The value of the corn crop alone in 1913 was $1,692,000,000, more than double the value of the principal mineral product—coal—and the total value of all grains was nearly $2,900,000,000. The marketed products of the barnyard, which include the poultry and dairy

products, are estimated to have been worth approximately $1,500,000,000 in 1913. The combined value of the grain, poultry, and dairy products was nearly double that of the entire mineral production. It should be remembered, however, that between the mining and the agricultural industries there are two essential differences: (1) With the exception of the forest products used for construction purposes (growing relatively smaller every year) the products of the farm, the ranch, and the garden are consumed in being applied to the use of man, whereas the products of the mines, with the exception of the fuels and the chemicals, are for the most part permanent additions to the national wealth. (2) The products of the farm are perennial, whereas those of the mines once extracted are never replenished, and the proper consideration of their utilization with the minimum waste is predicated upon a definite knowledge of their occurrence, methods of extraction, preparation, and application in the useful arts. The volumes of this series furnish a cyclopedia of information on the mineral resources of the United States.

COOPERATION WITH STATE GEOLOGICAL SURVEYS.

In the preparation of the present report, as of those for 1910, 1911, and 1912, the United States Geological Survey has had the active cooperation of most of the State geological surveys.[1] The statistics so obtained have been used jointly by the State and the Federal surveys, and the results have been checked before publication. The objects attained by cooperative agreement are four in number:

1. The avoidance of annoyance to the producers in the form of duplicate requests for the same statistical information.
2. The procuring of prompter and more complete returns.
3. The enabling of the State geologists to keep in touch with the producers and with new developments in their respective jurisdictions.
4. The avoidance of two divergent sets of statistics covering the same field and each bearing an official stamp, the existence of which is necessarily confusing to a student of the subject and tends to discredit one statement or the other, if not both.

Special acknowledgment is made of the assistance received by the United States Geological Survey from the directors of the State surveys; the cooperative arrangement has been carried out in a harmonious manner and with exceedingly gratifying results.

The officials who cooperated with the United States Geological Survey in 1913 are as follows:

Alabama	Dr. Eugene A. Smith, State geologist, University.
Florida	Dr. E. H. Sellards, State geologist, Tallahassee.
Georgia	Dr. S. W. McCallie, State geologist, Atlanta.
Illinois	Mr. Frank W. De Wolf, director, Urbana.
Iowa	Mr. George F. Kay, director, Iowa City.
Kansas	Dr. Erasmus Haworth, State geologist, Lawrence.
Maryland	Dr. William B. Clark, State geologist, Baltimore.
Michigan	Mr. R. C. Allen, director, Lansing.
Minnesota	Mr. W. H. Emmons, director, Minneapolis.
Missouri	Dr. H. A. Buehler, director, Rolla.
New Jersey	Dr. Henry B. Kümmel, State geologist, Trenton.

[1] The statistics relating to the production of gold, silver, copper, lead, zinc, and quicksilver are excepted from this cooperation.

New Mexico.....Dr. Charles T. Kirk, State geologist, Albuquerque.
North Carolina.....Dr. Joseph Hyde Pratt, State geologist, Chapel Hill.
Oklahoma.....Mr. C. W. Shannon, director, Norman.
Oregon.....Prof. H. M. Parks, director, Corvallis.
Pennsylvania.....Mr. Richard R. Hice, State geologist, Beaver.
Texas.....Dr. William B. Phillips, director, Austin.
Virginia.....Dr. Thomas L. Watson, director, Charlottesville.
Washington.....Mr. Henry Landes, State geologist, Seattle.
Wisconsin.....Mr. W. O. Hotchkiss, State geologist, Madison.

ORGANIZATION.

The division of mineral resources which compiles this series of reports is divided into two sections, namely, "metals" and "nonmetals." The annual report is published in two volumes, Part I being devoted exclusively to metals and Part II to fuels, structural materials, chemical minerals, and other nonmetallic products. Since 1907, when, at his own request, David T. Day was relieved as chief of division, the administration of the division of mineral resources has been under Edward W. Parker, statistician in charge. During the last two years the section of metals has been under the administrative charge of H. D. McCaskey, and the administration of the section of nonmetals has been conducted by the statistician in charge of the division. For the purpose, primarily, of facilitating the collection of statistics of the precious metals in the Western States and of providing convenient places for consulting the publications of the United States Geological Survey by the mining fraternity in the Rocky Mountain and Pacific coast States, offices are maintained in Denver, Colo., Salt Lake City, Utah, and San Francisco, Cal., Mr. McCaskey having general supervision of the western offices. The division of mineral resources works in close cooperation with the division of geology, and most of the chapters and subchapters of the annual volumes are prepared by geologists who have specialized in the subjects treated by them. The advantage of having the services of these specialists, who are familiar with the occurrence, treatment, and uses of the several mineral substances, is well recognized and has aided materially in maintaining the standard, broadening the scope, and increasing the usefulness of the reports. The chapters comprising the present report have been contributed by the following specialists:

General:
Edward W. Parker—Review of conditions in 1912 and 1913.
William T. Thom—Summary of mineral production.
In the section of metals:
H. D. McCaskey (in charge of section)—General report on gold and silver; gold, silver, copper, lead, and zinc in Eastern States (mines report); general supervision of reports on gold, silver, copper, lead, and zinc in Western States (mines report); quicksilver.
Ernest F. Burchard—Iron ore, pig iron, and steel.
D. F. Hewett—Manganese and manganiferous ores.
B. S. Butler—General report on copper; mines report on silver and copper in Michigan.
C. E. Siebenthal—General reports on lead, zinc, and cadmium.
W. C. Phalen—Bauxite and aluminum.
Frank L. Hess—Tin; arsenic; antimony; bismuth; selenium; tellurium; tungsten; vanadium; uranium; radium; nickel; cobalt; titanium; tantalum; molybdenum.
David T. Day—Platinum.
J. S. Diller—Chromic iron ore.
John P. Dunlop—Silver, copper, lead, and zinc in Central States, except Michigan (mines report); metals and metallic ores (summary); statistics of recovery of secondary metals.

Alfred H. Brooks—Gold, silver, and copper in Alaska (mines report).
Charles W. Henderson (in charge of Denver office)—Gold, silver, copper, lead, and zinc in Colorado, New Mexico, South Dakota, Wyoming, and Texas (mines report).
Charles G. Yale (in charge of San Francisco office)—Gold, silver, copper, lead, and zinc in California and Oregon (mines report).
Victor C. Heikes (in charge of Salt Lake City office)—Gold, silver, copper, lead, and zinc in Arizona, Utah, Nevada, and Montana (mines report).
Clarence N. Gerry (assistant to Victor C. Heikes)—Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).

In the section of nonmetals:

Edward W. Parker—Coal; coke; briquetting of fuels.
David T. Day—Petroleum; asphalt, bituminous rock, and related bitumens.
David T. Day and B. Hill—Natural gas.
Charles A. Davis—Peat.
Ernest F. Burchard—Stone; cement; fluorspar and cryolite.
Ernest F. Burchard and Warren E. Emley—Source, manufacture, and use of lime.
Jefferson Middleton—Clay-working industries; sand-lime brick; fuller's earth.
J. H. Hance—Notes on the occurrence and use of flint clays.
Ralph W. Stone—Gypsum; sand and gravel; lime.
A. T. Coons—Slate.
J. S. Diller—Asbestos; talc and soapstone.
W. C. Phalen—Phosphate rock; salt and bromine; potash salts; sulphur, pyrite, and sulphuric acid.
Frank J. Katz—Abrasive materials; silica (quartz) and feldspar.
James M. Hill—Mineral paints; barytes and strontium.
Douglas B. Sterrett—Gems and precious stones; mica; monazite.
E. S. Bastin—Graphite.
Charles G. Yale and Hoyt S. Gale—Borax; magnesite.
R. B. Dole—Mineral waters and their radioactivity.

The writer desires to express his high appreciation of the enthusiastic support and cooperation rendered by his associates in the preparation of this report, and in no less degree to acknowledge the efficient, loyal, and conscientious cooperation of the clerical and stenographic members of the division who have borne the brunt of the work in collecting the figures, scrutinizing and editing the schedules, and compiling the tables, a number of them doing double duty as stenographers and statistical clerks. The statistical tables accompanying this review were prepared by Miss M. B. Clark.

HISTORICAL REVIEW.

In the present report, as in the preceding reports of the series, the mineral production is treated primarily by subjects. For detailed discussion of the occurrence and production of each mineral substance by States the reader should consult the chapters by subjects in the two volumes of this report. The statistics of production include comparisons with earlier years, the figures for which are carried forward each year for convenient reference. The earlier volumes, beginning with that of 1882, the first of the series, should be consulted for other notes on occurrence, development, trade conditions, and uses, descriptions of mining districts, and other information of a technical character which it is impracticable to carry forward from year to year. In the 32 years from 1882 to 1913, inclusive, the value of the mineral products of the country has increased from $451,901,159 to $2,445,805,017 or about five and a half times. In 1880 according to the Tenth Census, the population of the United States numbered 50,189,209 persons, and the value of the mineral products as reported by the same authority was $364,928,298, so that the average production per inhabitant amounted to $7.27. At the taking of the Thirteenth Census in 1910 the population of the country had increased to 91,972,266 per-

sons, a gain of about 80 per cent. The value of the mineral production in 1910 was $1,992,405,727, indicating an increase in the 30 years of $1,627,477,429, or nearly 450 per cent. The average output per inhabitant in 1910 was $21.66. The Bureau of the Census estimates the population of the United States, including Alaska, in 1913, on July 1, at 97,228,000 persons and as the value of the mineral production in that year was $2,445,805,017, the average output per person as represented by value was $25.16. From 1880 to 1913 the population of the United States has increased a little less than 100 per cent, while the value of the mineral production has increased nearly sixfold. The per capita mineral production in 1913 as expressed in the value of the output was three and a half times that of 1880. The most striking increases which have been made in the 32 years covered by these reports have been in the production of iron, copper, and gold, the fuels (coal, petroleum, and natural gas), and in cement. These features were accentuated in the statistics of production in 1912, but in 1913 a reaction was noted in the production of copper and of gold, both of which showed decreases. The decrease in the production of copper was due in part to labor troubles in the Lake Superior district and to generally unfavorable trade conditions which depressed prices and restricted mining operations. The decreased production of gold appears to be due to the failing supply in some of the old and large producing districts, to replace which, new territory has not been developed. The value of the pig-iron product, including that made from foreign ores, has increased from $106,336,429 in 1882 to $458,342,345 in 1913 (marketed production), the value of the output in the later year being a little more than four and a quarter times that of the earlier. The maximum production of copper was made in 1912 when the value of that metal was $205,139,338, nearly 13 times that of 1882 ($16,038,091). Declines in prices and smaller production in 1913 brought the value of the copper product down to $189,795,035, or not quite 12 times the value of the output in 1882. Gold production also attained its maximum in 1912, being valued in that year at $93,451,500, nearly 3 times that ($32,500,000) produced in 1882. The value of the gold produced in 1913, for the reason above stated, was about $4,000,000 less than in 1912. Silver is the one important mineral product which has shown a decrease in value during the period covered by this series of reports, the value of the output in 1913 being about $800,000 less than in 1882. Silver production reached its high-water mark in 1891, when the output was valued at $57,630,000 (commercial value), or about $17,000,000 more than in 1913. This decrease, however, has been in the value of the product and not in the quantity. Compared with 1882 the quantity of silver produced in 1913 showed an increase of over 80 per cent and established the maximum record of 66,801,500 fine ounces. Advances in the metallurgy of silver since 1882, while increasing the output, have naturally lessened the cost of production, and the price of silver, not having a fixed value like gold, is only slightly more than half what it was 30 years ago. The production of lead has increased from 132,890 short tons, valued at $12,624,550, in 1882 to 436,430 tons, valued at $38,405,840; and the output of zinc has increased about tenfold, from 33,765 short tons, valued at $3,646,620, to 337,252 tons, valued at $37,772,224. The smelting of aluminum was practically an unknown art in 1882, while at the present time the consumption of

this metal in the United States is between 70,000,000 and 75,000,000 pounds, valued in 1913 at about $14,000,000.

The combined production of anthracite and bituminous coal has increased from 103,551,189 short tons, valued at $146,632,581, in 1882, to 570,048,125 tons, valued at $760,488,785, the output in 1913 being 5.5 times that of 1882 in quantity, and 5.2 times in value. The increase in the production of anthracite in Pennsylvania has been from 31,358,264 long tons to 81,718,680 tons, a gain of approximately 160 per cent. The production of bituminous coal has increased from 68,429,933 short tons to 478,523,203 tons, a gain of 600 per cent. In 1882 the petroleum product of the United States amounted to 30,349,897 barrels, valued at $23,631,165, and in 1913 it was 248,446,230 barrels, valued at $237,121,388, the output in 1913 being 8 times that of the earlier year in quantity, and more than 10 times in value. Natural gas among the fuels was like aluminum among the metals, almost an unknown quantity in the first year for which the volumes of the mineral resources were prepared. It had a reported value in 1882 of $215,000, this value at that time, and for a number of years afterwards, being estimated upon the value of the coal which was displaced by the use of natural gas. In 1913 the value of the natural gas produced in the United States was $87,846,677, there being only seven other mineral products whose value of production in 1913 exceeded that of natural gas.

The manufacture of Portland cement, which is now of such prime importance among the structural material products, was like natural gas for the fuels and aluminum for the metals, of almost negligible significance in 1882. The cement industry in the United States in 1882 was represented mainly by natural or Rosendale cement, the production of which amounted to 3,165,000 barrels. The quantity of Portland cement made in the United States in that year was only 85,000 barrels. In the 32 years of progress the manufacture of natural cement reached the zenith of approximately 10,000,000 barrels in 1899 and has declined to insignificant proportions. The manufacture of Portland cement has exhibited the most remarkable increase shown by any of the mineral products, having an output of nearly 90,000,000 barrels in 1913, or more than 1,000 times the output of 1882. By far the larger part of this great gain in the manufacture of Portland cement has been during the 13 years of the present century. In 1900 the production of Portland cement in the United States had risen to only 8,482,020 barrels, considerably less than 10 per cent of the output in 1913.

A striking illustration of the growth of the mining industry in the United States in the 32 years embraced in this historical review is afforded by the fact that in 1882 the total mineral production of the United States was valued at $451,901,159, which was exceeeded by nearly 1.5 per cent by the value of the pig iron alone produced in 1913 and was exceeded by the value of the coal product of 1913 by 68 per cent. In 1882 the value of the mineral products of the United States was approximately $1,200,000 a day; in 1913 it was $6,700,000. Of the total value of the mineral output the metals constitute about one-third and the nonmetals about two-thirds. The metallic products in 1913 were valued at $882,980,156, and the nonmetallic products at $1,562,324,861. The largest tonnage and the greatest value of all the mineral products are derived from the coal mines. The

production of coal in 1913 amounted to 570,048,125 short tons, valued at $760,488,785. Second in the total value of the production and first among the metals is pig iron. The output in 1913 was 30,388,935 long tons, valued at $458,342,345, and the marketed production of iron ore, as represented by the shipments in 1913, was 59,643,098 tons, valued at $130,905,558, the quantity of iron ore marketed being nearly double the quantity of pig iron made, while the value of the pig iron was 3.5 times the value of the iron ore produced.

RAW AND DERIVED PRODUCTS.

In compiling the statistics of mineral production the value of the metallic products is fixed upon the refined or partly refined metals, and is of course much greater than the value of the ores from which they are obtained. During recent years the statistics of pig-iron production have been supplemented by accurate determinations of the quantity of iron ore produced and the value thereof, but the quantity and value of the pig iron have been maintained as the units of output. The ores of the precious and semiprecious metals are commonly complex mixtures of several metals, and no quantities or values can be expressed until the contents are extracted in metallic form and become articles of commerce. Chromic iron ore, manganese ore, manganiferous ores, and bauxite (aluminum ore), are marketed as such. In the nonmetals the quantities are expressed and the value placed upon the products in the condition in which they are first sold. With the fuels, with phosphate rock, and with some of the other nonmetals the quantities and values represent the raw product. With cement, however, there is no commercial pro uct until the material is in the finished state as cement. The clay products appear as finished brick, terra cotta, tile, porcelain, pottery, etc., with the exception of a small quantity of special clays sold raw. The quarry products are sold rough, partly dressed, and finished; salt appears in various refined conditions, as the content of brine, and as rock salt; gypsum is sold at first hands, as crude, as ground, and as calcined. There is no uniformity and there is no way of arriving at the quantities and values of the quarry products except in the condition as first marketed. The desirability of continuing to base the figures of iron production on the output and value of pig iron may be open to some question, particularly as accurate records of the production of ore and of the sources from which it is obtained are now available. In addition to putting a factitious value on the output, the distribution of the production of pig iron by States gives undue prominence to the States in which the blast furnaces are located and deprives the ore-producing States of proper credit.

The publication of the introductory chapter on mineral products by States, which accompanied the report for 1911, brought out the fact that in certain other mineral substances, particularly those of a metallic nature, some States did not receive the proper credit as originating the production. With metallic copper, lead, and zinc (as reported by the smelters, not by the producers of the ores from which the metals are obtained) considered as the primary products, the value of the production of some States was unduly augmented, while that of others was correspondingly understated. In the present

chapter an attempt has been made to correct these discrepancies, so that in addition to crediting the iron-ore production to the originating States the recoverable value of the metallic contents of the gold, silver, copper, lead, and zinc is given for the ores produced according to the States in which they are mined.

With pig iron the basis of iron values, and the refined metals (smelter production) the basis of values for gold, silver, copper, lead, zinc, etc., the total value of the mineral production of the United States was $2,243,972,481 in 1912 and $2,445,805,017 in 1913, with Pennsylvania, Ohio, Illinois, and West Virginia as the four leading States. With iron ore as the basis of iron production, and with the recoverable metallic contents of ores as the basis of other metal output the total value of the mineral production was $1,918,474,249 in 1912 and $2,103,739,388 in 1913. The same four States remain at the head but in different order of precedence, all holding their rank because of their leading positions in the production of coal. Pennsylvania remains at the head, with West Virginia as second, Illinois third, and Ohio fourth. These four States are credited with about 45 per cent of the total value of the mineral output of the United States in 1913. California, with no standing as a producer of pig iron, iron ore, or coal, is fifth in rank and owes its position to its importance as a producer of petroleum and gold. Michigan was sixth in rank in 1912, but because of the decrease in the production and price of copper in 1913, dropped to eighth place, while Minnesota as the most important producer of iron ore advanced from ninth to sixth place, and Oklahoma, because of the increase in the production and the advance in the price of petroleum, advanced from twelfth place in 1912 to seventh in 1913. Michigan's production of iron ore increased in value in 1913, but this was not sufficient to overcome the large decrease in the value of copper. Arizona, which ranked eighth in 1912, fell to ninth place in 1913, and Montana, which held seventh place in 1912, dropped to tenth place in 1913, both of these being due to the decline in the copper production and value. Colorado, with gold, coal, and zinc as the principal products, ranked eleventh in both years, and Missouri, with lead and zinc as its chief products, fell from tenth to twelfth place because of the decline in the price of zinc. In the following table the States are arranged in the order of their rank as shown by the value of their mineral products in 1913, iron ore being taken as the basis of iron production, and the recoverable contents of the gold, copper, lead, zinc, etc. being taken as the basis of valuation of these metals.

63057°—M R 1913—VOL 1——II

Rank of States in value of mineral production in 1912 and 1913.

State.	Principal mineral products in 1913 (in order of value).	1912		1913			
		Rank.	Value.	Rank.	Value.	Increase (+) or decrease (—).	Percentage of increase (+) or decrease (—).
Pennsylvania	Coal, cement, clay products, natural gas	1	$445,799,653	1	$506,466,759	+$60,667,106	+13.61
West Virginia	Coal, natural gas, petroleum, clay products	2	123,847,812	2	143,640,633	+ 19,792,821	+15.98
Illinois	Coal, petroleum, clay products, cement	3	123,068,867	3	131,825,221	+ 8,756,354	+ 7.12
Ohio	Coal, clay products, petroleum, natural gas	4	111,229,656	4	121,690,661	+ 10,461,005	+ 9.40
California	Petroleum, gold, cement, copper	5	93,219,149	5	100,791,369	+ 7,572,220	+ 8.12
Minnesota	Iron ore, clay products, stone	9	66,672,729	6	85,814,533	+ 19,141,804	+28.71
Oklahoma	Petroleum, coal, natural gas, zinc	12	53,614,130	7	80,168,820	+ 26,554,690	+49.53
Michigan	Iron ore, copper, cement, salt	6	80,062,486	8	72,143,211	- 7,919,275	— 9.89
Arizona	Copper, gold, silver, lead	8	67,497,838	9	71,429,705	+ 3,931,867	+ 5.83
Montana	Copper, silver, coal, zinc	7	71,620,873	10	69,307,056	- 2,313,817	— 3.23
Colorado	Gold, coal, zinc, silver	11	58,167,399	11	54,294,281	- 3,873,118	— 6.66
Missouri	Lead, zinc, coal, clay products	10	58,332,550	12	54,001,088	— 4,331,462	— 7.43
Utah	Copper, silver, lead, coal	13	51,004,942	13	53,606,520	+ 2,601,578	+ 5.10
Indiana	Coal, cement, clay products, stone	14	42,239,193	14	46,607,864	+ 4,368,671	+10.34
New York	Clay products, stone, cement, iron ore	16	38,431,910	15	41,594,052	+ 3,162,142	+ 8.23
Nevada	Copper, gold, silver, zinc	15	39,111,828	16	37,842,084	— 1,269,744	— 3.25
New Jersey	Clay products, zinc, cement, stone	17	37,195,940	17	37,271,129	+ 75,189	+ .20
Alabama	Coal, iron ore, clay products, stone	18	30,641,983	18	34,660,545	+ 4,018,562	+13.11
Texas	Petroleum, coal, clay products, cement	21	22,797,015	19	31,666,910	+ 8,869,895	+38.91
Kansas	Coal, cement, natural gas, petroleum	19	26,554,967	20	27,312,563	+ 757,596	+ 2.85
Kentucky	Coal, clay products, stone	23	22,477,530	21	26,845,579	+ 4,368,049	+19.43
Iowa	Coal, clay products, cement, gypsum	20	22,900,350	22	25,602,015	+ 2,701,665	+11.80
Idaho	Lead, silver, copper, gold	24	21,816,390	23	24,565,826	+ 2,749,436	+12.60
Tennessee	Coal, copper, stone, phosphate rock	25	19,362,209	24	21,052,931	+ 1,690,722	+ 8.73
Louisiana	Petroleum, sulphur, natural gas	26	15,357,841	25	21,011,828	+ 5,653,987	+36.81
Alaska	Gold, copper, silver, stone	22	22,732,947	26	19,636,213	— 3,096,734	—13.62
New Mexico	Copper, coal, silver, zinc	29	14,391,355	27	17,862,369	+ 3,471,014	+24.12
Washington	Coal, cement, clay products, stone	27	15,347,313	28	17,579,743	+ 2,232,430	+14.55
Virginia	Coal, clay products, stone, iron ore	28	14,995,842	29	17,178,580	+ 2,182,738	+14.56
Wyoming	Coal, petroleum, iron ore, stone	31	13,374,088	30	13,682,091	+ 308,003	+ 2.30
Wisconsin	Zinc, stone, iron ore, clay products	30	14,192,287	31	12,452,480	— 1,739,807	—12.26
Maryland	Coal, clay products, stone, cement	32	10,851,671	32	11,292,723	+ 441,052	+ 4.06
Florida	Phosphate rock, clay products, fuller's earth, stone	33	10,272,594	33	10,508,016	+ 235,422	+ 2.29
Vermont	Stone, slate, talc and soapstone	34	9,087,560	34	9,647,985	+ 560,425	+ 6.17
South Dakota	Gold, stone, silver	35	8,436,240	35	7,888,411	— 547,829	— 6.49
Massachusetts	Stone, clay products, lime, mineral waters	36	6,654,514	36	7,044,529	+ 390,015	+ 5.86
Arkansas	Coal, bauxite, clay products, stone	38	6,258,726	37	6,780,760	+ 522,034	+ 8.34
Georgia	Clay products, stone, cement, coal	37	6,306,140	38	6,525,792	+ 219,652	+ 3.48
Maine	Stone, lime, clay products, mineral waters	39	3,925,526	39	4,429,584	+ 504,058	+12.84

Connecticut	Stone, clay products, lime, mineral waters	40	3,715,480	40	3,795,297	+ 79,817	+ 2.15
North Carolina	Clay products, stone, mica	41	3,368,923	41	3,739,696	+ 370,773	+11.01
Oregon	Gold, clay products, sand and gravel, stone	42	2,553,549	42	3,563,919	+ 1,010,370	+39.57
New Hampshire	Stone, clay products	43	1,949,876	43	2,218,925	+ 269,049	+13.80
South Carolina	Clay products, phosphate rock, stone	44	1,606,989	44	1,464,150	— 142,839	— 8.89
Nebraska	Clay products, stone, sand and gravel	45	1,490,582	45	1,433,718	— 56,864	— 3.81
Mississippi	Clay products, sand and gravel	46	1,242,528	46	1,143,472	— 99,056	— 7.97
North Dakota	Coal, clay products	47	1,025,741	47	1,055,676	+ 29,935	+ 2.92
Rhode Island	Stone, clay products	48	942,842	48	813,952	— 128,890	—13.67
Delaware	Stone, clay products, sand and gravel	49	425,360	49	541,542	+ 116,182	+27.31
District of Columbia	Clay products, sand-lime brick	50	300,336	50	246,582	— 53,754	—17.90
Total			[a] 1,918,474,219		[a] 2,103,739,388	+185,265,139	+ 9.66

[a] It must be remembered that in this table iron ore, not pig iron, is taken as the basis of iron valuation, and that in the case of other metals mine production (recoverable content of metals) is considered. With pig iron and the smelter figures for other metal production taken as the basis, in conformity with the usual custom, the total value of the mineral production of the United States in 1913 was $2,445,805,017, against $2,243,972,481 in 1912, the increase in the later year being $201,832,536 or 8.99 per cent.

It will be noted that in the 48 States and the Districts of Columbia and Alaska, included in the foregoing table, there were 37 in which the value of the mineral production in 1913 exceeded that of 1912; there were 13 in which the value in 1913 was less than in the preceding year. Of these 50 States 25, or exactly one-half, had a mineral production in 1913 valued at more than $20,000,000. Of these 25 States, 20 showed increase in 1913 and 5 decrease. The important increases were made in the States which are the large producers of coal, petroleum, and iron, exception being noted for Michigan, second in importance as an iron-ore State, the value of whose total production decreased because, as previously stated, of the decrease in the production of copper, until 1913 the most important mining product in the State. The principal decreases were in the States important as producers of copper, gold, and zinc, the most conspicuous decrease being in Michigan, where the decline in the output and value of copper caused a total decrease of $7,919,275 in the production of 1913 as compared with 1912, notwithstanding the fact that the iron-ore production showed a gain in value of over $4,400,000. Oklahoma led in the percentage of increased value with a total in 1913 nearly 50 per cent greater than that of 1912. Oregon, one of the less important producing States, was second in percentage of increase, with a gain of practically 40 per cent; Texas increased 39 per cent; Louisiana, 37 per cent; and Minnesota, 29 per cent. The increases in Oklahoma, Texas, and Louisiana were all due to the increase in the production and the sharp advance in the value of petroleum. Minnesota's gain was due to the increased production and the higher value of iron ore. The States showing the most important increases in 1913 were Pennsylvania, with coal as the most important factor, a gain of $60,667,106; Oklahoma, with petroleum as the leading product, a gain of $26,554,690; West Virginia, with the three fuels—coal, petroleum, and natural gas—as the leading products, a gain of $19,792,821; Minnesota, with iron ore as the leading factor, a gain of $19,141,804; and Ohio, with coal and clay products as the leading commodities, a gain of $10,461,005. The total increase in 1913 over 1912, iron ore considered as basis of iron production, was $185,265,139, or a little less than 10 per cent. The first five States, Pennsylvania, West Virginia, Illinois, Ohio, and California, in 1913 produced almost exactly 50 per cent of the total value of the mineral products.

The States west of Mississippi River, particularly those of the Rocky Mountain and Pacific coast divisions, are popularly considered as the mining States. It is interesting to note that of the ten leading States in 1913 five—Pennsylvania, West Virginia, Illinois, Ohio, and Michigan—are east of Mississippi River; four—California, Oklahoma, Arizona, and Montana—are west of it; and one—Minnesota—is divided by the river. The combined production of all the States east of Mississippi River, which aggregate less than 30 per cent of the total area of the country, exclusive of Alaska, is nearly two-thirds of the total; whereas the States west of the river, which aggregate about 70 per cent of the total area of the country, contribute slightly more than one-third of the total value of the output. The States ranking first in the production of coal, iron ore, stone, clay

products, natural gas, and most of the nonmetallic substances, with the exception of petroleum and sulphur, are east of Mississippi River, while those holding first place in the production of gold, silver, copper, lead, zinc, and petroleum, as well as those producing all of the quicksilver, platinum, and sulphur (except iron pyrite), are west of the river.

The present chapter is designed primarily to review briefly the mineral resources of the several States, and the production and condition of the industries during 1912 and 1913. The statistics of production according to substances are discussed at length in the chapters devoted to the different subjects. It seems pertinent, however, in preparing the statistics of the production by States and in discussing the products which give them prominence to call particular attention to a few interesting facts regarding some of the more important products. They group themselves naturally into three classes—metals, fuels, and structural materials.

The metal group in 1913 showed particularly interesting comparisons with 1912. Of the six important metals, three showed increases and three decreases. The production of pig iron exclusively from domestic ore increased from 28,981,195 long tons, valued at $402,378,453, to 29,145,034 tons, valued at $439,633,756; copper production decreased from 1,243,268,720 pounds to 1,224,484,098 pounds, with a decrease in value from $205,139,338 to $189,795,035; the value of the gold decreased from $93,451,500 to $88,884,400; the production of silver increased from $39,197,500 to $40,348,100; the lead production (smelter output) increased from 415,395 tons, valued at $37,385,550, to 436,430 tons, valued at $38,405,840; and the output of zinc increased in quantity from 323,907 to 337,252 short tons, and declined in value from $44,699,166 to $37,772,224. The combined value of these metals increased from $822,251,507 to $834,839,355, a gain of $12,587,848, or 1.53 per cent.

The three fuels—coal, petroleum, and natural gas—increased from $944,383,275 in 1912 to $1,085,456,850 in 1913, a total gain of $141,073,575, or 15 per cent. By far the largest gain, both in amount and percentage of value, was in the output of petroleum, which, while showing an increase of about 10 per cent in quantity, gained nearly $73,000,000, or 44 per cent in value. The increase in the combined production of anthracite and bituminous coal was $64,882,714, or 9 per cent; and the natural gas increased $3,282,720, or 3.9 per cent. The subjects grouped under structural materials are clay products, cement, stone, sand and gravel, and slate, all of which showed increase in production in 1913, cement carrying off the honor with a gain of nearly $20,000,000, or 28.7 per cent, over 1912, the clay products increasing approximately $7,000,000, or 5 per cent, and stone over $5,500,000, or 7 per cent. The total value of the structural materials included in this group was $346,973,263 in 1913, against $313,211,242 in 1912, a gain in 1913 of $33,762,021, or 10.8 per cent. The following table gives the production and value of the principal metals, fuels, and structural materials in 1912 and 1913, with, in each case, the four leading States contributing to the production. Following this table the discussion of the production in the last two years is taken up by States, alphabetically.

Production and value of principal metals, fuels, and structural materials in the United States, 1912 and 1913.

Mineral.	Principal producing States in 1913 (in order of value[a]).	1912			1913						
								Increase (+) or decrease (−) in value.			
								By minerals.		By groups.	
		Quantity.	Value.	Value by groups.	Quantity.	Value.	Value by groups.	Amount.	Per cent.	Amount.	Per cent.
Metals (from domestic ores):											
Pig iron[b] . . long tons. .	Pennsylvania, Ohio, Illinois, New York.	28,981,195	$402,378,453	$822,251,507	29,145,034	$439,633,756	$834,839,355	+$37,255,303	9.26	+$12,587,848	1.53
Copper.....pounds. .	Arizona, Montana, Utah, Michigan.	1,243,268,720	205,139,338		1,224,484,098	189,795,035		− 15,344,303	7.48		
Gold.....fine ounces. .	California, Colorado, Alaska, Nevada.	4,520,717	93,451,500		4,299,784	88,884,400		− 4,567,100	4.89		
Silver.....do....	Nevada, Montana, Utah, Idaho.	63,766,800	39,197,500		66,801,500	40,348,100		+ 1,150,600	2.94		
Lead.....short tons. .	Missouri, Idaho, Utah, Colorado.	415,395	37,385,550		436,430	38,405,840		+ 1,020,290	2.73		
Zinc.....do.....	Missouri, New Jersey, Colorado, Montana.	323,907	44,699,166		337,252	37,772,224		− 6,926,942	15.50		
Fuels:											
Coal.....do.....	Pennsylvania, West Virginia, Illinois, Ohio.	534,466,580	695,606,071	944,383,275	570,048,125	760,488,785	1,085,456,850	+ 64,882,714	9.33	+141,073,575	14.94
Petroleum....barrels. .	Oklahoma, California, Illinois, West Virginia.	222,935,044	164,213,247		248,446,230	237,121,388		+ 72,908,141	44.40		
Natural gas.....	West Virginia, Pennsylvania, Ohio, Oklahoma.	.....	84,563,957		.....	87,846,677		+ 3,282,720	3.88		
Structural materials:											
Clay products.....	Pennsylvania, Ohio, Illinois, New Jersey.	.....	136,307,111	313,211,242	.....	143,296,757	346,973,263	+ 6,989,646	5.13	+ 33,762,021	10.78
Cement[b] .....barrels. .	Pennsylvania, Indiana, California, New York.	85,925,651	69,554,385		89,541,348	89,550,527		+ 19,996,142	28.75		
Stone.....	Pennsylvania, Vermont, New York, Ohio.	.....	78,193,220		.....	83,732,995		+ 5,539,775	7.08		
Sand and gravel, short tons.	Pennsylvania, New York, Ohio, Illinois.	68,354,561	23,113,208		79,555,849	24,217,508		+ 1,104,300	4.78		
Slate.....	Pennsylvania, Vermont, Maine, Virginia.	.....	6,043,318		.....	6,175,476		+ 132,158	2.19		

[a] Rank of States in metal production (except pig iron) arranged according to mine reports, not smelter output.

[b] Marketed production.

INDIVIDUAL STATES.

ALABAMA.

With iron ore considered as the basis of iron production, Alabama ranks eighteenth among all the States in the value of its mineral products, and second among the States south of Mason and Dixon's line and Ohio River. If pig iron were taken as the basis of iron production, Alabama would rank about fifteenth among all the States, but would maintain the position it now holds among the Southern States. West Virginia, with its great production of mineral fuel—coal, petroleum, and natural gas—is the premier mineral producer among the Southern States. Alabama is not distinguished as the leading producer in any important mineral substance, but it ranks third in the production of iron ore, fifth in the production of pig iron, second in quantity and third in value in the production of coke, and sixth in quantity and fifth in value as a producer of coal. Considerable progress has been made in the development of the clay-working and quarrying industries, but these resources have not been exploited to the same extent as those of coal and iron.

The rise of Alabama as a mining and industrial Commonwealth had its beginning in the last quarter of the nineteenth century following the development in 1882 of the extensive deposits of iron ore in the vicinity of Birmingham and contiguous to the already partially known and developed coal fields. The boom and speculative fever which followed was one of the most spectacular incidents in the industrial development of the United States, paralleled only by the rushes which followed Marshall's discovery of gold in California, the exploitation of the Comstock lode in Nevada, and the later rush to the Alaskan gold fields. The speculative fever reached its climax in 1885, and was followed by a period of relapse and liquidation which lasted two years. There was beneath the Birmingham craze, however, a substantial foundation for legitimate industrial development, and after the bursting of the original bubble there has followed more than a quarter of a century of steady healthful growth. The iron ores of Alabama, while inferior to those of Lake Superior, have a compensating advantage in the deposits of good coking coal and of the limestone requisite for fluxing in the immediate vicinity, as the result of which Birmingham, the Pittsburgh of the South, can manufacture pig iron cheaper than any other district in the world. The iron ores are principally non-Bessemer hematites, and steel is produced chiefly by the open-hearth process. Prior to 1882 when the boom began, the coal production of Alabama had not amounted to as much as half a million tons in any one year. In 1885 it was nearly 2,500,000 tons, but in the collapse of 1886 that followed it decreased to 1,800,000. Since 1886 it has shown an almost unbroken series of annual increases in the production and reached its maximum of 17,678,522 tons in 1913, an increase of more than 1,500,000 tons over 1912, and exceeded, by approximately the same quantity, the previous maximum record made in 1910. The value of the coal product of Alabama is approximately two-thirds that of the total mineral output, and amounted in 1913 to $23,083,724.

In 1882 Alabama produced about 100,000 long tons of pig iron. In 1913 the marketed production of pig iron in Alabama amounted

to 1,924,762 long tons, valued at $23,242,374, a slight decrease in quantity from 1912 and an increase in value of nearly $2,000,000. The value of the pig iron produced in Alabama in both 1912 and 1913 was slightly in excess of the value of the coal mined. Although the production of pig iron in 1913 was less than in 1912, there was an increase in the production of iron ore from 4,776,545 long tons in 1912, valued at $5,734,371, to 5,333,218 long tons, valued at $6,648,569, in 1913. The value of this iron-ore production, not the value of the pig iron, is used in making up the total value of the mineral products of the State.

The coke production of Alabama increased from 2,975,489 short tons, valued at $8,098,412, in 1912 to 3,323,664 short tons, valued at $9,627,170, in 1913. The increase in the production of iron ore and in the manufacture of coke with the decreased sales of pig iron, indicate that some of the ore and of the coke was sent to furnaces outside of the State, although in addition to the actual marketed production of pig iron there was an increase in stock carried over to January 1, 1914, as compared with stocks on hand January 1, 1913.

The total value of the mineral production of Alabama, exclusive of the value of the pig iron and including the value of the iron ores, was $34,660,545 in 1913, compared with $30,641,983 in 1912, of which, as already stated, approximately two-thirds is represented by the output of the coal mines. Nearly one-fifth of the total value was contributed by the iron mines. The increase in 1913 over 1912 was $4,018,562, or 13 per cent. The principal coal-producing counties are Jefferson, Walker, Bibb, and Tuscaloosa, in the order named. The principal iron ore counties are Jefferson, Tuscaloosa, Etowah, and Franklin. The iron-making industry is centered in Birmingham and vicinity. The combined value of the pig iron and coke made in Alabama approximates $33,000,000. These values are not included in the total as they are represented in the value of the iron ore and the coal produced. The clay-working industries yielded products in 1913 valued at $2,091,581, against $1,935,179 in 1912, the principal part of which is from the manufacture of common brick. This does not include the value of raw clay sold, which in 1913 amounted to $53,419. The center of the clay-working industry is in Jefferson County, and Birmingham furnishes the principal market. Vitrified, front, and fire brick represent a value approximating that of common brick alone, and the total output of the brickyards makes up nearly 80 per cent of the State's total clay products. All of the fire brick produced in the State is reported from Jefferson County and all of the vitrified brick is from Jefferson and St. Clair counties. Clay pits for the manufacture of common brick have been opened in one or more places in 38 different counties. The quarry products, the larger part of which is limestone, were valued in 1913 at $1,285,944, an increase of more than 50 per cent from $842,300 in 1912. The increased production in 1913 was in the output of limestone for flux and concrete work, sandstone for use in Government improvements on Warrior River, and the production of marble. Two-thirds of the total value of the stone production is limestone. The most important use of the limestone is for blast furnace flux, with riprap, road making, and crushed stone following in the order named. Little of the Alabama limestone is used for building at the present time, but in the opinion of Dr. Eugene A. Smith this use is on the increase and is

due to the development of an oolitic limestone similar in appearance and composition to the Indiana stone. This stone is of light-gray color, uniform grain, and homogeneous texture. It possesses the quality of cheapness and can be cut to any design required. Marble holds second place in the value of the quarry products, a beautiful white marble occurring in Coosa and Talladega counties being used extensively for building, and black marble which gives promise of future development has been prospected near Anniston. The cement production of Alabama amounted in 1913 to 823,246 barrels, valued at $685,422, against 726,688 barrels, valued at $608,620, in 1912. The lime production is not included in that of the limestone, and amounted to 75,468 short tons, valued at $290,394 in 1913, a decrease from 79,957 short tons, valued at $297,178, in 1912. Alabama produces a small quantity of gold and silver, and other minor products are bauxite, graphite, mica, millstones, mineral paints (natural pigments), mineral waters, natural gas, and sand and gravel.

In the following table is presented a comparison of the mineral output of Alabama in 1912 and 1913. As stated above, the total does not include the value of pig iron nor that of coke, but it does include the value of the coal made into coke and of the iron ore sold or used:

Mineral production of Alabama in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bauxite...long tons..	14,173	$60,254			(a)	(a)		
Cement.....barrels..			726,688	$608,620			823,246	$685,422
Clay products, short tons	43,052	b 33,414		1,935,179	49,901	b $3,41[illegible]		2,091,581
Coal.....short tons..	16,100,60[illegible]	20,829,252			17,678,522	23,083,724		
Coke.....do....			2,975,489	b 8,098,412			3,323,664	b 9,627,170
Gold, fine ounces (troy)			809	16,724			537	11,094
Graphite, crystalline, pounds	(a)	(a)			2,020,910	87,336		
Iron ore...long tons.	4,776,54[illegible]	5,734,371			5,333,218	6,648,569		
Iron, pig.....do...			1,987,753	b21,371,0[illegible]			1,924,762	b23,242,374
Lime.....short tons..			79,957	297,178			75,468	290,394
Mica								(a)
Millstones				(a)				(a)
Mineral paints, natural pigments, short tons							(a)	(a)
Mineral waters, gallons sold	165,678	20,43[illegible]			169,637	19,343		
Natural gas		(a)				(a)		
Sand and gravel, short tons	872,943	268,111			1,405,068	398,088		
Silver, fine ounces (troy)			103	103			117	71
Stone		(c)		c 842,30[illegible]		(c)		c 1,285,944
Miscellaneous		(c)		c 29,456		46,618		12,361
Total value, eliminating duplications..	$30,641,983				$34,660,545			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included under derived product.

ALASKA.

Mining in Alaska is confined principally to the production of gold and copper, with a relatively small output of silver. Considerable quantities of gypsum are mined, some stone is quarried, and small quantities of coal, lead, tin, and petroleum have been produced. According to Alfred H. Brooks, geologist in charge of the division of Alaskan mineral resources, there was a marked falling off both in the production of gold and of copper in 1913 as compared with 1912—in fact, the year 1913 was one of general decrease. Of the nine mineral substances which are produced commercially in Alaska, six showed decreased output in 1913 and three showed increase. Two of the substances which showed increased production, coal and petroleum, are insignificant and do not affect the total production. The statistics of stone production are not published separately, because there are less than three producers in the Territory. The production of gold decreased from 829,435 fine ounces, valued at $17,145,951, in 1912 to 755,947 fine ounces, valued at $15,626,813. The copper production decreased from 29,230,491 pounds, valued at $4,823,031, in 1912 to 21,659,958 pounds, valued at $3,357,293. The production of silver in 1913 was 362,563 fine ounces, valued at $218,988, against 515,186 fine ounces, valued at $316,839, in 1912. Mr. Brooks states that the decrease in gold production in 1913 was chiefly from placer mines, the percentage of output from the lode mines having increased from 29 per cent in 1912 to 31.6 in 1913. In 1911 the percentage of gold from lode mines was 24. Mr. Brooks is of the opinion that this indicates a gradual transition from placer mining to lode mining. More than 60 per cent of the placer gold is still obtained from small washing operations, and in the opinion of Mr. Brooks the decrease in the production of placer gold will continue until the construction of railroads will have so reduced the cost of operations as to make the less valuable gravels available for exploitation. The production of placer gold decreased from $11,990,000 in 1912 to $10,680,000 in 1913, while the output from lode mines (siliceous ores) decreased much less in proportion, from $5,302,339 to $4,814,813. Nearly all of the silver and a small amount of gold is obtained as a by-product in copper mining.

The development of the coal resources of Alaska is still held back by lack of legislation permitting the exploitation of the known extensive and valuable fields. Patent for the opening of one coal mine, the Whorf, at Port Graham, was issued in 1913. This is the only coal mine to which patent has been issued. The mine is opened on about 65 acres and supplies a local market with a lignitic product. The total quantity of coal produced in Alaska in 1913 was 2,072 tons, valued at $11,100. This does not include about 1,000 tons taken from the Matanuska field for official use by the Navy Department. This coal was mined during the summer under the supervision of the Bureau of Mines and was sledded to Knik during the winter.

The following table gives the total quantity and value of Alaska's mineral production in 1912 and 1913:

Mineral production of Alaska in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value
Coal.....short tons..	355	$2,840	.....	.....	2,072	$11,100	.....	.....
Copper.....pounds..	.....	.....	29,230,491	$4,823,031	.....	.....	21,659,958	$3,357,293
Gold.....fine ounces (troy)..	.....	.....	829,435	17,145,951	.....	.....	755,947	15,626,813
Gypsum.....short tons..	(a)	.....	.....	(a)	(a)	.....	.....	(a)
Lead.....do....	.....	.....	(b)	(b)	.....	.....	6	528
Petroleum.....barrels..	(c)	(c)	.....	.....	(c)	(c)	.....	.....
Silver....fine ounces (troy)..	.....	.....	515,186	316,839	.....	.....	362,563	218,988
Stone.....	.....	.....	.....	(c)	.....	(c)	.....	.....
Tin.....short tons..	.....	.....	130	124,800	.....	.....	82	35,874
Miscellaneous.....	.....	(d)	.....	d 319,486	.....	.....	.....	385,617
Total value, eliminating duplications.....	$22,732,947				$19,636,213			

a Calcined in Washington State. Value included under "Miscellaneous."
b Smelter report shows small quantity of lead derived from concentrates of dry siliceous ores.
c Value included under "Miscellaneous."
d Raw product included in derived product.

ARIZONA.

Arizona ranks first among the States in the production of copper, and copper mining is by far the mainstay of the mining industry in the State, nearly 90 per cent of the total value of all the mineral products being represented by the value of the copper contained in the ores mined in the State. Moreover, Arizona is one of the few States in which the production of copper in 1913, both in quantity and value, exceeded that of 1912. The gain in value, however, was less than half proportionately to the increase in output, the total production having shown an increase of more than 10 per cent in quantity, with a gain of less than 5 per cent in value. Copper production showed in 1912 also a notable increase over 1911. The large increase in both years has been due principally to the development of steam-shovel operations on the low-grade schists and porphyry (concentrating) ores of the Ray district in Pinal County and to activity in the Miami district in Gila County. The leading counties in the production of copper are Cochise, Greenlee, Gila, Pinal, Yavapai, and Pima. The recoverable copper content of the ores mined in Arizona increased from 365,038,649 pounds, valued at $60,231,377, in 1912, to 407,923,402 pounds, valued at $63,228,127 in 1913.

Second in importance among the mineral products of Arizona is gold, in the production of which Arizona ranks seventh. The principal gold producing districts are in Mohave, Maricopa, Yavapai, Santa Cruz, and Yuma counties, and about two-thirds of the production is from siliceous ores; the other one-third of the gold production is obtained in the reduction of copper ores. Arizona's total production of gold in 1913 was 194,657 fine ounces, valued at $4,023,911, against 181,997 fine ounces, valued at $3,762,210, in 1912. Silver production principally from Cochise and Yavapai counties, and largely a by-

product from the smelting of the copper ores, amounted to 3,948,091 fine ounces, valued at $2,384,647, in 1913, against 3,490,387 fine ounces, valued at $2,146,588 in 1912. Some lead and zinc is also produced in the State, the former having a value of a little over $700,000 and the latter of nearly $530,000 in 1913. The nonmetalliferous products of the State are cement, clay wares, fluorspar, gypsum, gems, lime, sand and gravel, silica, stone, and sulphuric acid. The combined value of these, however, was little more than $500,000, or less than 1 per cent of the total value of the mineral products of the State. Small quantities of quicksilver and tungsten ores are also produced. The total value of the mineral products of the State increased from $67,497,838 in 1912, to $71,429,705 in 1913, as shown in the following table:

Mineral production of Arizona in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cement.....barrels							(a)	(a)
Clay products				$178,564				$218,542
Copper.....pounds			365,038,649	60,231,377			307,923,402	63,228,127
Fluorspar... short tons					(a)	(a)		
Gems and precious stones				15,975				8,000
Gold..fine ounces (troy)			181,997	3,762,210			194,657	4,023,911
Gypsum.....short tons	(a)			(a)	(a)			(a)
Lead.....do			3,403	306,290			8,072	710,370
Lime.....do			18,528	101,680			18,292	99,550
Quicksilver.....flasks							(a)	(a)
Sand and gravel, short tons	(a)	(a)			(a)	(a)		
Silica.....do	(a)	(a)			(a)	(a)		
Silver, fine ounces (troy)			3,490,387	2,146,588			3,948,091	2,384,647
Stone		(b)		b 67,124		(b)		b 107,989
Sulphuric acid (60° Baumé)c...short tons			(a)	(a)			(a)	(a)
Tungsten ore (60 per cent concentrates), short tons			27	9,566			16	6,069
Zinc.....short tons			4,379	604,319			4,714	527,972
Miscellaneous		$6,525		67,620		$17,911		96,617
Total value, eliminating duplications	$67,497,838				$71,429,705			

a Value included under "Miscellaneous."
b Stone sold rough included in derived product.
c From copper smelting.

ARKANSAS.

Arkansas is first among the States in the production of two minerals—bauxite and novaculite, the former being the ore of aluminum and the latter the source of the larger part of the oilstones produced in the United States. The principal mineral product, however, is coal, the annual value of which constitutes over 50 per cent of the State's total. The total value of all the mineral products of Arkansas in 1913 was $6,780,760, as compared with $6,258,726 in 1912. The coal production was 2,234,107 short tons, valued at $3,923,701, in 1913, against 2,100,819 tons, valued at $3,582,789, in 1912. Coal is mined in 6 counties, but approximately 70 per cent of the total production comes from Sebastian County. Franklin and Johnson counties together produce about 27 per cent of the total. The coals

of Arkansas are generally of high grade, particularly in the eastern part of the field, where they approach anthracite in character. The semianthracite of Arkansas is an excellent domestic fuel, reaching markets as far north as Kansas City. Mining conditions are exacting, however, and the cost of labor is high. Competition with more cheaply mined coals of Alabama and Illinois to the east and with Colorado and New Mexico coals to the west has kept the coal-mining industry of Arkansas practically at a standstill during the last decade. The industry has suffered also from competition with petroleum and natural gas from the Mid-Continent field, though during 1912 and 1913 the withdrawal of considerable quantities of fuel oil from the market has had beneficial effect upon the coal mining industry. The output in 1913 was only 106,399 tons more than the average yearly output during the decade ended in that year.

Bauxite is second among the mineral products of the State. It is mined near Benton, in Saline County, and in Pulaski County. In 1913 the stone quarries of Arkansas furnished products valued at $525,050, exclusive of novaculite and of limestone burned for lime. In 1912 the quarry products were valued at $513,844. The clay-working industries, while not highly developed, take third place in the value of output. In 1913 the clay products of Arkansas, about 75 per cent of which is common brick, were valued at $529,624, an increase of $67,019 over 1912. The sand and gravel pits yielded $320,639 in 1913 and $393,639 in 1912. The only metalliferous products of Arkansas besides bauxite are lead, zinc, and manganiferous ores. Other commercial products are fullers earth, gems and precious stones, lime, mineral waters, natural gas, phosphate rock, and slate.

The statistics of the mineral production of Arkansas in 1912 and 1913 are shown in the following table:

Mineral production of Arkansas in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bauxite.....long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Clay products.....	.....	.....	.....	$462,605	.....	.....	.....	$529,624
Coal.....short tons..	2,100,819	$3,582,789	.....	.....	2,234,107	$3,923,701	.....	.....
Fuller's earth.....do...	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gems and precious stones.	.....	.....	.....	1,175	.....	.....	.....	6,200
Lead.....short tons..	.....	.....	31	2,790	.....	.....	18	1,584
Lime.....do....	.....	.....	22,404	102,833	.....	.....	19,391	95,846
Manganiferous ore, long tons.....	1,332	2,997	.....	.....	9,650	19,250	.....	.....
Mineral waters, gallons sold.....	1,396,032	132,257	.....	.....	1,428,869	151,412	.....	.....
Natural gas.....	.....	(a)	.....	.....	.....	(a)	.....	.....
Oilstones.....	.....	.....	.....	112,047	.....	.....	.....	(a)
Phosphate rock, long tons.....	(a)	(a)	.....	.....	.....	.....	.....	.....
Sand and gravel, short tons.....	1,217,740	393,639	.....	.....	821,456	320,639	.....	.....
Slate.....	.....	.....	.....	(a)	.....	.....	.....	.....
Stone.....	.....	(b)	.....	b 513,844	.....	(b)	.....	b 525,050
Zinc.....short tons..	.....	.....	748	103,224	.....	.....	478	53,536
Miscellaneous.....	.....	(b)	.....	b 848,526	.....	(b)	.....	b 1,153,918
Total value, eliminating duplications....	$6,258,726				$6,780,760			

a Value included under "Miscellaneous." b Raw product included under derived product.

It will be noted that in the 48 States and the Districts of Columbia and Alaska, included in the foregoing table, there were 37 in which the value of the mineral production in 1913 exceeded that of 1912; there were 13 in which the value in 1913 was less than in the preceding year. Of these 50 States 25, or exactly one-half, had a mineral production in 1913 valued at more than $20,000,000. Of these 25 States, 20 showed increase in 1913 and 5 decrease. The important increases were made in the States which are the large producers of coal, petroleum, and iron, exception being noted for Michigan, second in importance as an iron-ore State, the value of whose total production decreased because, as previously stated, of the decrease in the production of copper, until 1913 the most important mining product in the State. The principal decreases were in the States important as producers of copper, gold, and zinc, the most conspicuous decrease being in Michigan, where the decline in the output and value of copper caused a total decrease of $7,919,275 in the production of 1913 as compared with 1912, notwithstanding the fact that the iron-ore production showed a gain in value of over $4,400,000. Oklahoma led in the percentage of increased value with a total in 1913 nearly 50 per cent greater than that of 1912. Oregon, one of the less important producing States, was second in percentage of increase, with a gain of practically 40 per cent; Texas increased 39 per cent; Louisiana, 37 per cent; and Minnesota, 29 per cent. The increases in Oklahoma, Texas, and Louisiana were all due to the increase in the production and the sharp advance in the value of petroleum. Minnesota's gain was due to the increased production and the higher value of iron ore. The States showing the most important increases in 1913 were Pennsylvania, with coal as the most important factor, a gain of $60,667,106; Oklahoma, with petroleum as the leading product, a gain of $26,554,690; West Virginia, with the three fuels—coal, petroleum, and natural gas—as the leading products, a gain of $19,792,821; Minnesota, with iron ore as the leading factor, a gain of $19,141,804; and Ohio, with coal and clay products as the leading commodities, a gain of $10,461,005. The total increase in 1913 over 1912, iron ore considered as basis of iron production, was $185,265,139, or a little less than 10 per cent. The first five States, Pennsylvania, West Virginia, Illinois, Ohio, and California, in 1913 produced almost exactly 50 per cent of the total value of the mineral products.

The States west of Mississippi River, particularly those of the Rocky Mountain and Pacific coast divisions, are popularly considered as the mining States. It is interesting to note that of the ten leading States in 1913 five—Pennsylvania, West Virginia, Illinois, Ohio, and Michigan—are east of Mississippi River; four—California, Oklahoma, Arizona, and Montana—are west of it; and one—Minnesota—is divided by the river. The combined production of all the States east of Mississippi River, which aggregate less than 30 per cent of the total area of the country, exclusive of Alaska, is nearly two-thirds of the total; whereas the States west of the river, which aggregate about 70 per cent of the total area of the country, contribute slightly more than one-third of the total value of the output. The States ranking first in the production of coal, iron ore, stone, clay

products, natural gas, and most of the nonmetallic substances, with the exception of petroleum and sulphur, are east of Mississippi River, while those holding first place in the production of gold, silver, copper, lead, zinc, and petroleum, as well as those producing all of the quicksilver, platinum, and sulphur (except iron pyrite), are west of the river.

The present chapter is designed primarily to review briefly the mineral resources of the several States, and the production and condition of the industries during 1912 and 1913. The statistics of production according to substances are discussed at length in the chapters devoted to the different subjects. It seems pertinent, however, in preparing the statistics of the production by States and in discussing the products which give them prominence to call particular attention to a few interesting facts regarding some of the more important products. They group themselves naturally into three classes—metals, fuels, and structural materials.

The metal group in 1913 showed particularly interesting comparisons with 1912. Of the six important metals, three showed increases and three decreases. The production of pig iron exclusively from domestic ore increased from 28,981,195 long tons, valued at $402,378,453, to 29,145,034 tons, valued at $439,633,756; copper production decreased from 1,243,268,720 pounds to 1,224,484,098 pounds, with a decrease in value from $205,139,338 to $189,795,035; the value of the gold decreased from $93,451,500 to $88,884,400; the production of silver increased from $39,197,500 to $40,348,100; the lead production (smelter output) increased from 415,395 tons, valued at $37,385,550, to 436,430 tons, valued at $38,405,840; and the output of zinc increased in quantity from 323,907 to 337,252 short tons, and declined in value from $44,699,166 to $37,772,224. The combined value of these metals increased from $822,251,507 to $834,-839,355, a gain of $12,587,848, or 1.53 per cent.

The three fuels—coal, petroleum, and natural gas—increased from $944,383,275 in 1912 to $1,085,456,850 in 1913, a total gain of $141,073,575, or 15 per cent. By far the largest gain, both in amount and percentage of value, was in the output of petroleum, which, while showing an increase of about 10 per cent in quantity, gained nearly $73,000,000, or 44 per cent in value. The increase in the combined production of anthracite and bituminous coal was $64,882,714, or 9 per cent; and the natural gas increased $3,282,720, or 3.9 per cent. The subjects grouped under structural materials are clay products, cement, stone, sand and gravel, and slate, all of which showed increase in production in 1913, cement carrying off the honor with a gain of nearly $20,000,000, or 28.7 per cent, over 1912, the clay products increasing approximately $7,000,000, or 5 per cent, and stone over $5,500,000, or 7 per cent. The total value of the structural materials included in this group was $346,973,263 in 1913, against $313,211,242 in 1912, a gain in 1913 of $33,762,021, or 10.8 per cent. The following table gives the production and value of the principal metals, fuels, and structural materials in 1912 and 1913, with, in each case, the four leading States contributing to the production. Following this table the discussion of the production in the last two years is taken up by States, alphabetically.

Mineral production of California in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt..short tons..	36,741	$100,481	212,590	$2,085,922	27,870	$69,825	204,228	$1,680,179
Borax.....do....	42,315	1,127,813	.....	.....	58,051	1,491,530	.....	.....
Briquets, fuel..do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Cement.....barrels..	.....	.....	6,093,790	8,215,894	.....	.....	6,018,262	8,896,734
Chromite..long tons..	201	2,753	.....	.....	255	2,854	.....	.....
Clay products, short tons.....	102,520	b 139,919	.....	5,912,450	153,871	b 167,309	.....	5,344,958
Coal.....short tons..	10,978	23,601	.....	.....	24,839	84,073	.....	.....
Copper.....pounds..	.....	.....	33,451,672	5,519,526	.....	.....	34,575,007	5,359,126
Feldspar..short tons..	(a)	(a)	.....	.....	1,113	3,838	.....	.....
Fuller's earth..do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gems and precious stones.....	.....	.....	.....	45,330	.....	.....	.....	26,507
Gold, fine ounces (troy).....	.....	.....	953,639	19,713,478	.....	.....	987,187	20,406,958
Graphite, amorphous, short tons.....	.....	.....	.....	.....	(a)	(a)	.....	.....
Gypsum..short tons..	47,741	.....	.....	219,317	49,015	.....	.....	230,936
Infusorial earth.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Iron ore...long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Iron, pig.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Lead.....short tons..	.....	.....	572	51,512	.....	.....	1,757	154,631
Lime.....do....	.....	.....	72,978	555,822	.....	.....	73,715	569,874
Magnesite.....do....	10,512	84,096	.....	.....	9,632	77,056	.....	.....
Manganese ore, long tons.....	(a)	(a)	.....	.....	.....	.....	.....	.....
Mineral paints, natural pigments, short tons.....	.....	.....	290	3,610	.....	.....	365	3,174
Mineral waters, gallons sold.....	2,089,951	532,971	.....	.....	2,801,393	531,925	.....	.....
Natural gas.....	.....	1,134,456	.....	.....	.....	1,883,450	.....	.....
Petroleum...barrels..	87,268,536	39,616,387	.....	.....	97,788,525	45,709,400	.....	.....
Platinum, fine ounces (troy).....	.....	.....	603	19,899	.....	.....	368	17,802
Pumice..short tons..	(a)	(a)	.....	.....	.....	.....	.....	.....
Pyrite....long tons..	61,812	201,453	.....	.....	70,536	218,525	.....	.....
Quicksilver...flasks..	.....	.....	20,524	863,034	.....	.....	15,591	627,228
Salt.....barrels..	(a)	(a)	1,064,286	609,396	(a)	(a)	1,050,229	745,708
Sand and gravel, short tons.....	2,189,432	518,516	.....	.....	1,836,012	439,009	.....	.....
Sand-lime brick.....	.....	.....	.....	33,860	.....	.....	.....	38,839
Silica.....short tons..	(a)	(a)	.....	.....	.....	.....	.....	.....
Silver, fine ounces (troy).....	.....	.....	1,300,136	799,584	.....	.....	1,378,399	832,553
Stone.....	.....	(c)	.....	c3,902,313	.....	(c)	.....	c4,118,935
Sulphuric acid (60° Baumé)d, short tons	.....	.....	(a)	(a) (e)	.....	.....	(a)	(a)
Talc.....short tons..	.....	.....	1,169	15,653	(c)	(c)	c 952	c 6,000
Tungsten ore (60 per per cent concentrates), short tons..	.....	.....	(a)	(a)	.....	.....	541	226,260
Zinc.....do....	.....	.....	2,173	299,846	.....	.....	529	59,219
Miscellaneous.....	.....	40,835	.....	1,112,817	.....	18,657	.....	1,209,539
Total value, eliminating duplications..		$93,219,149				$100,791,369		

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.
d From copper smelting.
e Includes small value for electrolyte.

COLORADO.

Colorado does not lead in the production of any important mineral substance, although it closely approximates California in the production of gold, and has in former years been the leading producer of that metal. It ranks eleventh among the mineral-producing States and fifth among the States west of Mississippi River. It is the leading producer of tungsten ores and vanadium minerals, and ranks second in the production of gold, third in the production of zinc, and fourth in lead and fluorspar. The product of chief value is gold, the production of which in 1913 was almost exactly one-third the total value of the mineral products of the State. Teller County produces more than one-half of the total gold output of the State, all from deep mines and all from siliceous ores unmixed with other metals. The other important gold-producing counties are San Miguel, Ouray, Lake, San Juan, Gilpin, and Clear Creek. Ninety-five per cent of the total output of gold in Colorado is from siliceous ores. The production decreased from 899,222 fine ounces, valued at $18,588,562, in 1912, to 877,857 fine ounces, valued at $18,146,916.

Second in importance among the State's mineral products is coal, of which the leading counties are Las Animas, contributing about 45 per cent of the total output, and Huerfano second with between 15 and 20 per cent. Other important producing counties are Boulder, Fremont, Gunnison, Weld, and Routt. On account of labor troubles in the last quarter of the year, the production of the State decreased from 10,977,824 short tons, valued at $16,345,336 in 1912, to 9,232,510 tons, valued at $14,035,090.

The production of zinc, which showed a marked increase in 1912 over 1911, suffered a decrease in 1913, which was particularly emphasized in the value of the output. The recoverable zinc content of the ores mined in Colorado in 1913 was 59,673 short tons, valued at $6,683,400, against 66,111 tons, valued at $9,123,374, in 1912. The zinc-mining operations are third in importance in Colorado's mining industry.

Colorado leads all of the Western States in the manufacture of pig iron, but produces only a small quantity of iron ore. The ore from which the iron is made in Colorado is mined principally in New Mexico and Wyoming, and the value of the pig iron produced in the State is not included in the total mineral production.

Silver ranks fourth in the value of Colorado's mineral product, and, unlike gold, showed an increase in output in 1913. The silver production is principally from dry and siliceous gold and silver ores and from silver-lead ores, the principal producing counties being, in order, Lake, San Miguel, Mineral, Ouray, Pitkin, Clear Creek, San Juan, and Gilpin. The same counties furnish the larger part of the lead production, which also showed an increased output in 1913. The production of silver in the State increased from 8,212,070 fine ounces, valued at $5,050,423, in 1912 to 9,325,255 fine ounces, valued at $5,632,454. The recoverable lead content of the ore increased from 37,621 short tons, valued at $3,385,902, to 43,949 short tons, valued at $3,867,502. The other mineral products which had a total value in excess of $1,000,000 in 1913 were clay products and copper. The output of the stone quarries exceeded that amount in 1912, but fell slightly below it in 1913. The other mineral products of the

State are cement, fuller's earth, gems, graphite, gypsum, lime, manganiferous ore, mica, mineral waters, natural gas, petroleum, sand and gravel, sand-lime brick, and sulphuric acid (from zinc smelting).

On account chiefly of the decreased production of coal and zinc the total value of the mineral products of Colorado decreased from $58,167,399 in 1912 to $54,294,281 in 1913. The output for the two years, distributed by substances, is shown in the following table:

Mineral production of Colorado in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons.....	72,435	b $72,105	.....	$1,437,394	65,579	b $70,350	.....	$1,293,511
Coal.....short tons..	10,977,824	16,345,336	.....	.....	9,232,510	14,035,090	.....	.....
Coke.....do....	.....	.....	972,941	b3,043,994	.....	.....	879,461	b2,815,134
Copper.....pounds..	.....	.....	7,107,303	1,172,705	.....	.....	7,227,826	1,120,313
Ferro-alloys, long tons.....	.....	.....	.....	.....	.....	.....	(a) (b)	(a) (b)
Fluorspar, short tons.....	1,639	9,834	.....	.....	4,432	26,592	.....	.....
Fuller's earth..do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gems and precious stones.....	.....	.....	.....	4,506	.....	.....	.....	2,139
Gold, fine ounces (troy).....	.....	.....	899,222	18,588,562	.....	.....	877,857	18,146,916
Graphite, amorphous, short tons.....	.....	.....	.....	.....	(a)	(a)	.....	.....
Gypsum .short tons..	(a)	.....	.....	(a)	(a)	.....	.....	(a)
Iron ore...long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Iron, pig.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Lead.....short tons..	.....	.....	37,621	3,385,902	.....	.....	43,949	3,867,502
Lime.....do....	.....	.....	7,281	36,478	.....	.....	7,875	46,390
Manganiferous ore, long tons.....	48,618	12,646	.....	.....	49,753	5,874	.....	.....
Mica.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Mineral waters, gallons sold.....	1,178,308	75,314	.....	.....	1,053,429	89,820	.....	.....
Natural gas.....	.....	(a)	.....	.....	.....	(a)	.....	.....
Petroleum...barrels..	206,052	199,661	.....	.....	188,799	174,779	.....	.....
Sand and gravel, short tons.....	112,514	45,983	.....	.....	90,578	28,306	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Silver, fine ounces (troy).....	.....	.....	8,212,070	5,050,423	.....	.....	9,325,255	5,632,454
Stone.....	.....	(c)	.....	c1,420,607	.....	(c)	.....	c985,817
Sulphuric acid (60° Baumé)d short tons.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Tungsten ore (60 per cent concentrates), short tons.....	.....	.....	812	297,533	.....	.....	953	428,760
Uranium and vanadium ores, short tons.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Zinc.....short tons..	.....	.....	66,111	9,123,374	.....	.....	59,673	6,683,400
Miscellaneous.....	.....	102,736	.....	6,285,149	.....	66,121	.....	6,376,296
Total value, eliminating duplications..	$58,167,399				$54,294,281			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.
d From zinc smelting.

CONNECTICUT.

Connecticut's only claim to recognition as a mineral-producing State is based upon the output of its quarries and its clay and sand pits. The total value of the mineral products of the State has never exceeded $4,000,000, and the highest point was probably reached in 1913, with a value of $3,795,297. Of this total, the quarry products, including the limestone burned into lime and the feldspar used in the manufacture of pottery, represented $2,101,780, or nearly 60 per cent. The stone quarries alone yielded products valued at $1,603,663, against $1,467,458 in 1912. The principal stone quarried is designated in the trade as granite, although much of the material quarried under the name of granite is, in reality, gneiss. The quarrying of trap rock is also an important industry, the value of the output being about 75 per cent of that of the granite or gneiss. The granite (or gneiss) is used chiefly in building, monumental work, for riprap, and in the manufacture of paving blocks, but by far the larger part of the trap rock is crushed for road making, railroad ballast, and concrete, and consequently represents a lower value per unit of output than that of the other stone used for building and monumental work. According to Prof. William North Rice, superintendent of the Connecticut Geological and Natural History Survey, granite, or gneiss, is quarried in every county in the State. The principal operations are in New Haven and New London counties, and there are others of considerable importance in Windham and Fairfield counties. Trap rock is produced chiefly in Hartford and New Haven counties. In addition to granite and trap rock, commercial quarries of red sandstone are operated in Hartford, Middlesex, and New Haven counties, and some marble has been produced in Litchfield County. Limestone, which is used chiefly as crushed stone for concrete, for flux, and for lime burning, is quarried in Litchfield, Hartford, and Fairfield counties. Some marble has also been quarried in Litchfield County. The total production of lime in Connecticut in 1913 was 76,192 short tons, valued at $382,347, against 75,981 tons, valued at $371,356, in 1912. The feldspar production increased from 19,075 short tons, valued at $94,097, in 1912 to 20,288 short tons, valued at $115,770, in 1913. In the quarrying of this product Connecticut holds a relatively high position, being third among the States in the quantity and value of the feldspar produced.

The clay-working establishments are principally in the Connecticut River valley and the products consist chiefly of common brick, which constitutes nearly 90 per cent of the total value of the clay products. The total value of the clay products in 1913 was $1,411,392, against $1,507,787 in 1912. Fire clay occurs in Litchfield County, but no refractory products are manufactured within the State. Kaolin suitable for porcelain is dug in Litchfield County and shipped to potteries outside the State. Kaolin also occurs in Fairfield and Hartford counties. Mineral waters to the value of $136,878 were sold in Connecticut in 1913, and sand and gravel pits produced 24,252 tons of material, valued at $7,272. An inconsiderable quantity of iron ore is mined and a small quantity of pig iron is made in Connecticut; but aside from that there is no other metal mining nor metallurgy in the State nor is there any production of

mineral fuel. The production of pig iron in 1913 showed a decrease of about 40 per cent as compared with 1912. Connecticut's other commercial mineral products are infusorial earth, quartz (silica), sand-lime brick, and occasional finds of precious stones. The total value of all the mineral products of the State in 1913, as shown in the following table, was $3,715,480 in 1912 and $3,795,297 in 1913. The quarry products all showed increases and the other products decreases in 1913.

Mineral production of Connecticut in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products..short tons..	.....	.....	.....	$1,507,787	(a) (b)	(a) (b)	.....	$1,411,392
Feldspar.....do....	19,075	$94,097	.....	.....	20,288	$115,770	.....	.....
Gems and precious stones..	.....	.....	.....	.....	.....	.....	.....	200
Infusorial earth.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Iron ore.....long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Iron, pig.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Lime.....short tons..	.....	.....	75,981	371,356	.....	.....	76,192	382,347
Mineral waters, gallons sold.....	2,110,231	153,383	.....	.....	2,458,327	136,878	.....	.....
Sand and gravel, short tons.....	20,823	7,805	.....	.....	24,252	7,272	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	.....
Silica.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Stone.....	.....	(c)	.....	c1,467,458	.....	(c)	.....	c1,603,663
Miscellaneous.....	.....	100,394	.....	419,279	.....	137,589	.....	240,536
Total value, eliminating duplications....	$3,715,480				$3,795,297			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

DELAWARE.

Delaware's title as a mineral-producing State, like that of Connecticut, is based on the production of its quarries, its clays, its sand and gravel pits, and its sales of potable waters. In colonial time and during the early years of national life Delaware was of some relative importance as a producer of iron ore for bloomeries and forges, but with the rise of the blast furnaces and the disappearance of the bloomaries Delaware's iron-mining industry ceased to exist and no iron ore has been produced in the State for many years. The total mineral production of Delaware increased from $425,360 in 1912 to $541,542 in 1913. The chief item of increase was in the output of stone used for rubble and riprap, the total quarry products showing an increase of 50 per cent, from $193,074 to $289,987. The principal clay product is common brick with relatively small quantities of front brick. The total value of the clay products increased from $162,216 to $187,280. In addition to the brick manufactured in the State, some raw clay (kaolin) is dug in Newcastle County and shipped to potteries outside the State. There was a slight decrease in the values of mineral waters sold and of the sand and gravel production in 1913, as compared with the preceding year.

The statistics of mineral production in Delaware in 1912 and 1913 are given in the following table:

Mineral production of Delaware in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products...short tons..	13,688	[a]$61,754	.....	$162,216	11,482	[a]$66,647	.....	$187,280
Mineral waters..gallons sold..	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Sand and gravel..short tons..	129,157	62,047	.....	.....	127,875	58,675	.....	.....
Stone.....	.....	(c)	.....	[c]193,074	.....	(c)	.....	[c]289,987
Miscellaneous.....	.....	8,023	.....	.....	.....	5,600	.....	.....
Total value, eliminating duplications.....	$425,360				$541,542			

[a] Value not included in total value.
[b] Value included under "Miscellaneous."
[c] Stone sold rough included in derived product.

DISTRICT OF COLUMBIA.

The mineral production in the District of Columbia is principally the output of the clay beds in the vicinity of Washington. The products from these are common building brick, draintile, sewer pipe, and fireproofing. Small quarries have been operated at irregular intervals in the deposits of gneiss and granite which occur in the District, the operations usually being carried on by contractors furnishing stone for foundations, and, in a few instances, for relatively small structures. These stones are also used crushed for road material. Some building sand is dredged from Potomac River, and some sand is also dug at Lamond station and used at one plant in the District in the manufacture of sand-lime brick. The waters from two springs are sold commercially. The total value of the mineral production decreased from $300,336 in 1912 to $246,582 in 1913, as shown in the following table:

Mineral production of the District of Columbia in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products.....	.....	.....	.....	[a]$217,486	.....	.....	.....	$160,014
Mineral waters..gallons sold..	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Sand and gravel..short tons..	.....	.....	.....	.....	(b)	(b)	.....	.....
Sand-lime brick.....	.....	.....	.....	(b)	.....	.....	.....	(b)
Miscellaneous.....	.....	(c)	.....	[c]82,850	.....	(c)	.....	[c]86,568
Total value, eliminating duplications.....	$300,336				$246,582			

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Raw product included in derived product.

FLORIDA.

Florida lays claim to some importance as a mineral-producing State by reason of the exploitation of its deposits of phosphate rock. Florida ranks first among all of the States in the quantity and value of phosphate-rock production, and that item represents 90 per cent of the value of the State's total mineral output. Public attention was first called to the possibilities of this now important industry in the report, Mineral Resources of the United States, 1884; but workable deposits were not discovered until 1888, and production on a commercial scale was begun in 1889. In 1894 Florida as a producer of phosphate rock outclassed South Carolina, which, prior to the development of the Florida deposits, had enjoyed a practical monopoly of that particular mineral product. The value of the phosphate production of Florida now approximates $10,000,000 annually. In 1913 the output amounted to 2,545,276 long tons, valued at $9,563,084 against 2,406,899 long tons, valued at $9,461,297, in 1912. In the early days of the industry in Florida four kinds of phosphate rock were produced, namely, hard rock, soft rock, land pebble, and river pebble. Soft rock, which is of a much lower grade than the other types, has not been mined for several years, and only an insignificant output of river pebble is produced at the present time. Land pebble constitutes approximately 80 per cent of the total quantity produced, but only about two-thirds of the total value. Hard rock is generally of higher grade than pebble and brings about twice as much per ton to the producers. At one time the only phosphate for which there was any demand for export was hard rock, but in recent years the grade of land pebble has been materially improved by methods of mining and treatment before shipment, and the exports of the Florida rock now include not only practically all of the hard rock produced, but also about one-third of the land pebble. The total production of hard rock in 1913 was 489,794 long tons, valued at $2,987,274, an average of $6.10 per ton. The production of pebble, which included an insignificant quantity of river pebble, was 2,055,482 long tons, valued at $6,575,810, an average of $3.20 per ton. In 1912 the hard-rock production was 493,481 long tons, valued at $3,293,168, an average of $6.67 per ton, and the pebble production was 1,913,418 long tons, valued at $6,168,129, or an average of $3.22 per ton. Florida's relative importance as a producer of phosphate rock is indicated by the fact that both in quantity and value it now contributes more than 80 per cent of the total phosphate-rock production in the United States. The leading counties, according to the value of the marketed product, are, in order given, Polk, Citrus, Hillsborough, Alachua, and Marion; it is mined to a small extent in Hernando and Columbia counties, and was formerly produced in De Soto and Orange counties.

Florida is also the premier State in the production of fuller's earth, a variety of clay used for filtering and clarifying animal, mineral, and vegetable oils. Relative to the total production of the State, the value of the fuller's earth production is of minor importance, but considered in its relation to the total production of fuller's earth, it is an important factor, as Florida contributes about 70 per cent of the total output of fuller's earth, both in quantity and value. The discovery of fuller's earth in Florida was entirely accidental and occurred in 1893, 20 years before the period covered by the present report. It

resulted from an unsuccessful attempt to make brick from clay found on the property of the Owl Cigar Co., near Quincy. When it was found impossible to make brick from the clay, a resemblance of the material to German fuller's earth was recognized by an employee of the company, and tests developed the fact that in many respects the material was equal to the imported earth. Mining began in 1895, and is now an industry of some importance. The necessity of withholding certain confidential information furnished by producers causes the output of fuller's earth in Florida to be included among the miscellaneous items.

Florida leads also in the production of ball clay, a highly plastic clay used in giving plasticity to the body of better grades of pottery. This output, however, is also included with the miscellaneous products in order to maintain the confidential character of the reports to the Geological Survey. The manufactured clay products of the State, consisting principally of common brick, were valued at $253,344 in 1913, compared with $272,766 in 1912. The manufacture of sand-lime brick has been developed to some extent in Florida, but the production in 1913 was considerably less than that in 1912. The other mineral substances which are commercially developed are limestone for lime, mineral waters, sand and gravel, and building stone, the last mentioned being entirely limestone. Part of the limestone is suitable for cement material, but it has not been utilized for that purpose. Extensive deposits of peat occur throughout the State, and some "machine peat" was made at Orlando, in Orange County, several years ago; but the attempted development of that mineral resource has not resulted in commercial enterprises.

The total value of the mineral products of Florida in 1913, as shown in the following table, was $10,508,016, as compared with $10,272,594 in 1912.

Mineral production of Florida in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products.short tons..	(a) (b)	(a) (b)	.....	$272,766	(a) (b)	(a) (b)	.....	$253,344
Fuller's earth.....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Infusorial earth.....	.....	.....	.....	.....	.....	.....	.....	(a)
Lime.....short tons..	.....	.....	12,327	69,938	.....	.....	16,845	89,973
Mineral waters, gallons sold.....	123,485	$17,521	.....	.....	343,123	$37,474	.....	.....
Phosphate rock, long tons.....	2,406,899	9,461,297	.....	.....	2,545,276	9,563,084	.....	.....
Sand and gravel, short tons.....	115,450	21,050	.....	.....	87,061	21,194	.....	.....
Sand-lime brick.....	.....	.....	.....	121,378	.....	.....	.....	79,679
Stone.....	.....	(c)	.....	(a)	.....	(c)	.....	c 207,420
Miscellaneous.....	.....	(c)	.....	c 428,384	.....	(c)	.....	c 384,098
Total value, eliminating duplication.	$10,272,594				$10,508,016			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

GEORGIA.

Georgia ranks second among all of the States in the production of five mineral substances, namely, barytes, bauxite, fuller's earth, natural mineral paints, and paper clay, and was one of two States reporting a production of asbestos in 1913, but is still of relatively minor importance when compared with the other States in the total value of its mineral products. It is not an important producer of metals or metallic ores, and its only mineral fuel is coal, a small quantity of which is mined annually in the northwest corner of the State. The total value of the mineral products of Georgia in 1913 was a little over $6,500,000, nearly 80 per cent of which was from its clay pits and stone quarries. It ranks third among the Southern States and thirteenth among all of the States in the value of its clay products, which consist chiefly of common brick, front brick, and sewer pipe. The manufactured clay products were valued at $2,692,619 in 1913, against $2,806,541 in 1912. The deposits of clay suitable for brick manufacture are, in fact, in nearly every county of the State. Paper clay is dug in Glasscock, Randolph, Richmond, Taylor, Twiggs, and Williamson counties, and pottery-clay deposits have been developed in various parts of the State.

The quarry products, consisting principally of granite and marble, were valued at $2,105,366 in 1913, against $1,983,016 in 1912. Georgia granites have a high reputation for building purposes, and its marbles are greatly prized for their structural and decorative qualities. The chief granite-quarrying counties are Dekalb and Hancock, and its principal marble-quarrying industry is in Pickens County.

Small portions of the Walden coal basin of Tennessee and of the Lookout coal basin of Alabama are in the northwest corner of Georgia, in Dade and Walker counties. Coal has been mined in both counties, but in 1912 and 1913 coal-mining operations were limited to Walker County. The total production increased from 227,503 short tons, valued at $338,426, in 1912, to 255,626 tons, valued at $361,319, in 1913. Portland cement was manufactured in Polk and Walker counties, and natural cement in Bartow County, but owing to the necessity for maintaining the confidential character of reports to the Geological Survey the figures for 1913 can not be published. A substantial increase, however, was made over the output in 1912, when 359,769 barrels of cement, valued at $311,616, were made and sold. Georgia is one of the chief sources of the supply of ocher, included in the production of mineral paints, the output of which in 1913 was 11,869 short tons, valued at $123,616, against 10,112 tons in 1912, valued at $101,819. The sand and gravel pits contributed $166,798 to the total value of the mineral products in 1913 and $171,129 in 1912. Small quantities of iron ore are mined in Bartow, Chattooga, Gilmer, Gordon, Meriwether, Polk, and Walker counties and shipped to furnaces at Chattanooga, Tenn. The total production of iron ore in 1913 was 153,336 long tons, valued at $237,876. Other commercial mineral products are asbestos, barytes, bauxite, fuller's earth, occasional gems, gold, graphitic shale used for a color maker in fertilizers, lime, mineral waters, pyrite, sand-lime brick, silver, slate, talc, and tripoli. The total value of the mineral prod-

ucts of Georgia in 1913 amounted to $6,525,792, against $6,306,140 in 1912, as shown in the following table:

Mineral production of Georgia in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	(a)	(a)	.....	.....	1,100	$11,000	.....	.....
Barytes.....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Bauxite.....long tons..	19,587	$30,701	.....	.....	(a)	(a)	.....	.....
Cement.....barrels..	.....	.....	359,769	$311,616	.....	.....	(a)	(a)
Clay products....short tons..	75,815	b244,953	.....	2,806,541	156,374	b324,671	.....	$2,692,619
Coal.....do....	227,503	338,426	.....	.....	255,626	361,319	.....	.....
Coke.....do....	.....	.....	43,158	b161,842	.....	.....	42,747	b186,304
Fuller's earth.....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gems and precious stones....	.....	.....	.....	.....	.....	.....	.....	2
Gold.....fine ounces (troy)..	.....	.....	695	14,360	.....	.....	731	15,108
Graphitic shale.....	.....	.....	.....	.....	.....	(a)	.....	.....
Iron ore.....long tons..	135,337	227,282	.....	.....	153,336	237,876	.....	.....
Lime.....short tons..	.....	.....	(a)	(a)	.....	.....	3,550	13,483
Mineral paints, natural pigments.....short tons..	.....	.....	10,112	101,819	.....	.....	11,869	123,616
Mineral waters..gallons sold..	861,365	55,031	.....	.....	750,893	69,442	.....	.....
Pyrite.....long tons..	(a)	(a)	.....	.....	11,110	55,094	.....	.....
Sand and gravel..short tons..	445,122	171,129	.....	.....	407,853	166,798	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Silver....fine ounces (troy)..	.....	.....	77	47	.....	.....	75	46
Slate.....	.....	.....	.....	.....	.....	.....	.....	(a)
Stone.....	.....	(c)	.....	c1,983,016	.....	(c)	.....	c2,105,366
Talc.....short tons..	.....	.....	(a)	(a)	(c)	(c)	(a)	(a)
Tripoli.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Miscellaneous.....	.....	137,695	.....	78,477	.....	209,109	.....	464,915
Total value, eliminating duplications.....	$6,306,140				$6,525,792			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

IDAHO.

The mining industry of Idaho centers largely in the Cœur d'Alene lead-silver mining district in Shoshone County. Lead is the product of chief value, constituting approximately 60 per cent of the State's total mineral production and more than twice the value of silver, which ranks second among the State's mineral products. All but about 6 per cent of the recoverable lead content of the ores mined in Idaho is from the Cœur d'Alene district. In 1913 the recoverable lead content of the ores mined in Idaho amounted to 158,936 short tons, valued at $13,986,366, against 142,093 short tons, valued at $12,788,355, in 1912. Idaho ranks second among the States in the production of lead ores, its output of this product being exceeded by the soft-lead production of Missouri. The Missouri lead ores, however, contain no silver; and if the silver values were added to the value of the lead production of Idaho that State would have the lead of Missouri by a comfortable margin. The recoverable silver content of the ores mined in Idaho in 1913 was valued at $6,033,473, against $5,101,268 in 1912. About 91 per cent of the total silver produced in the State is from Shoshone County. Copper, gold, and zinc are also produced in significant quantities in Idaho, the output of each having a value of over $1,000,000 in 1913. Gold is

the only one of the metals produced in Idaho, the greater portion of which is not from Shoshone County. The most important county in the production of gold is Boise, with from 35 to 40 per cent of the total, and is followed somewhat closely by Owyhee County as second, with Lemhi County third. The total value of the metals contained in the ores mined in Idaho in 1913 was $24,168,339, or 98 per cent of the total mineral production. The total value of the nonmetallic products was $397,487, or 2 per cent of the total. The nonmetallic products consist of clay wares, coal (lignite), gem materials, lime, mica, phosphate rock, salt, sand and gravel, sand-lime brick, and stone. Small quantities of iron and tungsten ores are also produced in the State. The nonmetallic resource of greatest promise is phosphate rock, of which there are extensive deposits in the southeastern part of the State, extending over into northeastern Utah and southwestern Wyoming. As the agricultural industries of the Western States are developed this necessary plant food, which is abundant in the region mentioned, should become one of the most important items in the mineral production of Idaho.

The total value of the mineral products of Idaho increased from $21,816,390 in 1912 to $24,565,826 in 1913, as shown in the following table:

Mineral production of Idaho in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products, short tons	(a) (b)	(a) (b)		(a)	(a) (b)	(a) (b)		(a)
Coal, short tons	2,319	$6,603			2,143	$5,149		
Copper, pounds			7,492,152	$1,236,205			9,592,966	$1,486,910
Gems and precious stones				100				15
Gold, fine ounces (troy)			66,816	1,381,214			65,043	1,344,559
Iron ore, long tons	(a)	(a)			(a)	(a)		
Lead, short tons			142,093	12,788,355			158,936	13,986,366
Lime, do			7,402	42,380			4,133	22,413
Mica				(a)				(a)
Phosphate rock, long tons	(a)	(a)			(a)	(a)		
Salt, barrels			(a)	(a)			(a)	(a)
Sand and gravel, short tons	(a)	(a)			(a)	(a)		
Sand-lime brick				25,121				16,479
Silver, fine ounces (troy)			8,294,745	5,101,268			9,989,193	6,033,473
Stone		(c)		c 63,974		(c)		c 152,390
Tungsten ore (60 per cent concentrates), short tons			(a)	(a)			(a)	(a)
Zinc, short tons			6,955	959,479			11,587	1,297,741
Miscellaneous		22,898		188,923		53,636		166,770
Total value, eliminating duplications	$21,816,390				$24,565,826			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

ILLINOIS.

Illinois, third among the States in the value of its mineral production, owes its prominence as a mining State chiefly to its importance as a producer of coal and petroleum and to the development of the clay-working industries. In the quantity and value of coal produced, Illinois is exceeded only by Pennsylvania and West Virginia, which States also rank first and second, respectively, in the total value of their mineral production. Illinois likewise ranks third in the production of petroleum, being exceeded in this respect by California and Oklahoma, and is now the most important State east of Mississippi River as a producer of petroleum. In the value of manufactured clay products it ranks fourth, with Ohio, Pennsylvania, and New Jersey as first, second, and third, respectively.

The total value of the mineral production of Illinois in 1913 was $131,825,221, of which the coal mines contributed $70,313,605, or 53 per cent; petroleum wells, $30,971,910, or 23 per cent; and the brickyards, tile works, and potteries, $15,195,874, or 12 per cent. In 1912 the total value of the production was $123,068,867, of which $70,294,338 was in the value of the coal produced, $24,332,605 in the value of the petroleum, and $15,210,990 in the value of the clay products. From this it appears that of the total increase of $8,756,354 in 1913 over 1912, the oil wells contributed $6,639,305, the value of the coal and the clay products in 1913 being only slightly changed from that of 1912, clay products showing a slight decrease and the coal a slight increase. A somewhat remarkable difference is shown in the statistics of coal and those of petroleum in Illinois during the last two years. The coal production increased nearly $1,750,000 short tons in quantity, with an insignificant increase in value, while the production of petroleum decreased 4,700,000 barrels in quantity with an increase of over $6,600,000 in value. Illinois is an important manufacturer of pig iron, being exceeded in this respect only by Pennsylvania and Ohio; but it produces no iron ore. The iron furnaces, located principally in the northern part of the State, convenient to Lake transportation, receive their supplies of iron ore from Lake Superior. Illinois now also takes an important position in the manufacture of coke, but at least 70 per cent of the raw coal used in the coke ovens is drawn from the mines of West Virginia. In the retort coke ovens at South Chicago all of the coal used is from West Virginia, and at Joliet the charging mixture at one establishment consists of one-third West Virginia (Pocahontas) and two-thirds Pennsylvania (Youghiogheny), while at the other it consists approximately of 70 per cent West Virginia coal with 30 per cent Illinois and Pennsylvania coal. Neither the value of the pig iron nor that of the coke is included in the total value of the State's mineral production. If the value of these products in 1913 were added, the total value of the mineral products of the State would be increased by nearly $55,000,000. Fourth in importance among the mineral industries of the State is the manufacture of Portland cement, this product having a value in 1913 of $4,784,696, an increase of $1,340,611 over 1912. The quarry products contributed $4,140,953 in 1913, an increase of about $300,000 over 1912.

There are 102 counties in Illinois, and coal is or has been mined in 51, or exactly one-half of them. The counties credited with the

largest production are in the southern part of the State and also in the southwestern part, adjacent to the city of St. Louis, although large mining operations are also carried on in the northern part of the State where the mines are closer to the Chicago markets. The reason for the larger production of the southern part of the State seems to be that the beds in that section are thicker than those worked in the northern part, and, moreover, the Chicago market is one which to a considerable extent is supplied by West Virginia coal. Williamson and Franklin counties, in the southern part of the State, are the two most important producers, the former having an output in 1913 of 7,644,397 tons, and the latter a production of 6,072,102 tons. Sangamon and Macoupin counties, which form the more important part of the Springfield-Belleville belt, each contributed over 5,000,000 tons. Two other counties—St. Clair and Saline—produced over 4,000,000 tons each, and Madison and Vermilion counties each exceeded 3,500,000 tons. There were eight other counties which produced in excess of 1,000,000 tons, and three of these exceeded 2,000,000 tons. The total coal production of Illinois increased from 59,885,226 short tons, valued at $70,294,338, in 1912, to 61,618,744 short tons, valued at $70,313,605, in 1913. The increase in quantity was 1,733,518 tons, while the increase in value was insignificant, amounting to only $19,267. The relative decrease in value is attributed to the exceptionally mild weather in the early winter, which had a depressing influence on the domestic trade, while the water-power development of the Kankakee Dam has seriously affected the demand and prices for steam coal within a radius of 250 miles of the dam.

Petroleum, which ranks second among the mineral products of Illinois, and in the output of which Illinois ranks third among the States, showed a decrease in quantity from 28,601,308 barrels in 1912 to 23,893,899 barrels in 1913. This decrease in output inspired the spectacular rise in price, and, notwithstanding the decline of 4,707,409 barrels in quantity, the value increased by $6,639,305, from $24,332,605 to $30,971,910. Although the production of petroleum in appreciable quantities from Illinois began less than 10 years ago, the State now ranks third as a petroleum producer, and since 1907 has held first place in this respect among the States east of Mississippi River. Prior to 1905 the oil production of Illinois was measured by a few hundred barrels annually, but in the latter half of that year, owing to some developments near Casey, in Clark County, the production rose to over 180,000 barrels. Within the next three years the oil-producing territory was considerably extended and the production rose to nearly 33,700,000 barrels in 1908. The indications are that unless there is a considerable extension of the oil-producing territory, Illinois will not maintain its present rank for any great length of time. The production has declined steadily since 1910, and in 1913 the production was only a little more than 70 per cent of the output in 1910. The principal petroleum producing counties are Lawrence, Clark, Crawford, Clinton, Marion, and Cumberland. The development work which was mentioned in this chapter for 1912 as having been in progress in Wabash County has not resulted in any important addition to the supply.

Some natural gas is produced in the State, but when compared with the output of the other fuels—coal and petroleum—it is insignificant. In 1913 the value of the natural gas produced in the State was $574,015, as compared with $616,467 in 1912. The three fuels had a combined value in 1913 of $101,859,530, or 77 per cent of the total mineral value of the State. In 1912 the fuel values were $95,243,410, also 77 per cent of the total.

Illinois is one of the leading States in the utilization of its clay resources. In the value of manufactured clay products it ranks fourth among the States, with a total in 1913 of $15,195,874, compared with $15,210,990 in 1912. Clay products might be made in any of the 102 counties of the State. The raw material is present everywhere, and fuel is abundant and cheap. The clay-working industry is, however, concentrated in a large measure in the vicinity of Chicago, Cook County, and this district contributes over 40 per cent of the total for the State. Other important clay-producing counties are Lasalle, Knox, Livingston, Vermilion, and Kankakee, each of which had an output in excess of $500,000 during the last two years. The principal clay products of the State are building brick, vitrified brick, architectural terra cotta, drain tile, and pottery. In the value of its brick and tile products Illinois ranks third, and according to the Thirteenth Census of the United States it also ranks third in the value of its total manufactures.

The marketed production of Portland cement increased from 4,602,617 barrels, valued at $3,444,085, in 1912 to 4,734,540 barrels, valued at $4,784,696. The cement plants are located principally in the northern part of the State convenient to the Chicago market and to water transportation on Lake Michigan. The principal quarry product of Illinois is limestone, and Cook, Kankakee, Vermilion, and Will counties are the leading producers. The total value of the stone produced in the State increased from $3,841,504 in 1912 to $4,140,953 in 1913. The production of sand and gravel increased from 6,957,901 short tons, valued at $1,929,822, in 1912 to 7,992,140 tons, valued at $2,070,491, in 1913.

Illinois ranks first in the production of fluorspar, mined at Rosiclare in the southern part of the State, and in the production of "tripoli," a residual siliceous material used as a basis for abrasives and for filtration. Other products of the State are: Asphalt, lead, lime, mineral paints, mineral waters, pyrite (a by-product from coal mining), silver, sulphuric acid (from zinc smelting), and zinc.

The output of pig iron, which is not included in the total value, amounted to 2,892,263 long tons, valued at $45,796,966, in 1913, against 2,806,378 long tons, valued at $42,828,816, in 1912. In addition to the pig iron, ferro-alloys amounting in total value to over $800,000 are made within the State. The figures of lead, silver, and zinc production given in the following table are the quantity and value of the recoverable metallic content of the ores mined within the State. The statistics of production in the last two years are presented in the following table:

Mineral production of Illinois in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt, short tons			(a)	(a)			(a)	(a)
Briquets, fuel, short tons			(a) (b)	(a) (b)				
Cement....barrels			c 4,602,617	c $3,444,085			c 4,734,540	c $4,784,696
Clay products, short tons	176,558	b $192,663		15,210,990	194,937	b $204,037		15,195,874
Coal....short tons	59,885,226	70,294,338			61,618,744	70,313,605		
Coke.....do			1,764,944	b 8,069,903			1,859,553	b 8,593,581
Ferro-alloys, long tons			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Fluorspar, short tons	(a)	(a)			85,854	550,815		
Iron, pig, long tons			2,806,378	b42,828,816			2,892,263	b45,796,966
Lead...short tons			1,282	115,380			959	84,392
Lime.....do			98,450	394,892			95,977	433,331
Mineral paints, zinc-lead pigments, short tons			(a)	(a)			(a)	(a)
Mineral waters, gallons sold	1,143,625	74,445			1,216,442	68,549		
Natural gas		616,467				574,015		
Petroleum, barrels	28,601,308	24,332,605			23,893,899	30,971,910		
Pyrite..long tons	27,008	62,980			11,246	31,966		
Sand and gravel, short tons	6,957,901	1,929,822			7,992,140	2,070,491		
Silver, fine ounces (troy)			4,731	2,909			3,541	2,139
Stone		(d)		d 3,841,504		(d)		d 4,140,953
Sulphuric acid (60° Baumé)e, short tons			160,378	1,064,564			195,145	1,303,986
Tripoli				27,339				128,892
Zinc....short tons			4,065	560,970			2,236	250,432
Miscellaneous		(d)		d 1,992,632				1,756,126
Total value, eliminating duplications		$123,068,867				$131,825,221		

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of natural cement, value for which is included under "Miscellaneous."
d Raw product included in derived product.
e From zinc smelting.

INDIANA.

The principal mineral products of Indiana are coal, cement, clay products, and stone, the aggregate value of these four substances in 1913 exceeding 90 per cent of the total value of the output of the mines and quarries. In 1913 the total value of the mineral production of Indiana was $46,607,864. To this total the coal mines contributed $19,001,881, or 41 per cent, the Portland cement plants $10,218,867, or 22 per cent, the clay products $8,498,646, or 18 per cent, and the stone quarries $4,676,689, or 10 per cent. In 1912 the mineral output of the State was valued at $42,239,193, compared with which the production in 1913 shows an increase of $4,368,671, or 10.34 per cent. These values do not include that of the pig iron produced in the State, which in 1912 exceeded $17,000,000, and in 1913 was over $20,600,000, nor do they include the value of the coke produced, which in 1913 amounted to nearly $13,200,000. In the production of coal, which is the principal mineral product of the State, Indiana ranks seventh with an output in 1913 amounting to 17,165,671

short tons, valued at $19,001,881, as compared with 15,285,718 short tons, valued at $17,480,546, in 1912. The coal-producing counties are all in the southwestern part of the State and embrace an area of approximately 6,500 square miles. The principal producing counties are Greene, Sullivan, and Vigo, the last two having an output in 1913 exceeding 3,000,000 tons each. Greene County's production in 1913 was about 2,800,000 tons. Only two other counties, Knox and Vermilion, have produced as much as 1,000,000 tons a year.

With an increased production from 9,634,582 barrels, valued at $7,237,591, in 1912, to 10,219,492 barrels, valued at $10,218,867, in 1913, the Portland cement industry became second among Indiana's activities in mineral production. In 1912 the clay-working industries held second place, with products valued at $7,935,251. In 1913 the value of the clay products was $8,498,646.

The centers of cement manufacture are at Buffington, Stroh, and Syracuse, in the northern part of the State, and at Mitchell and Speeds, in the southern part. The leading counties in the manufacture of clay products are Clay, Lake, Vigo, Parke, and Madison. The principal clay products are draintile, building brick, and vitrified brick. The draintile works are mainly in Vermilion County. In the manufacture of encaustic tile Indiana ranks third among the States, the under clay of the coal beds furnishing an excellent base for this product and for the manufacture of fire brick. The encaustic tile plants are situated at or near Indianapolis.

The value of the quarry products decreased from $5,091,924 in 1912 to $4,676,689 in 1913. The principal stone product of the State is the Bedford limestone quarried in Lawrence and Monroe counties, which is highly prized for structural purposes.

Since the completion of the plant of 560 retort coke ovens by the United States Steel Corporation at Gary, Indiana has assumed importance as a manufacturer of coke, and advanced from the relatively low place (seventeenth in 1910) to third place in quantity and second in value in 1912 and 1913. In addition to the plant at Gary there are 100 retort ovens at Indianapolis, 50 of which were completed in 1913, 22 at Muncie, and 66 at Indiana Harbor. Another plant of 41 ovens is under construction at Indianapolis. The production of coke in Indiana in 1913 amounted to 2,727,025 short tons, valued at $13,182,136, an increase from 2,616,339 short tons, valued at $12,528,685, in 1912.

The value of the natural gas produced in Indiana decreased from $1,014,295 in 1912 to $948,278 in 1913. The production of petroleum decreased from 970,009 barrels to 956,095 barrels, while the value increased from $885,975 to $1,279,226. Sand and gravel pits yielded a product valued at $1,175,370 in 1912 and at $1,260,672 in 1913. The other mineral products of the State are gems (occasionally), lime, mineral paints, mineral waters, oilstones, pyrite, sand-lime brick, and sulphuric acid (from zinc smelting).

The distribution of the mineral production of the State in 1912 and 1913 is shown in the following table:

Mineral production of Indiana in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel, short tons	.....	.....	(a)(b)	(a)(b)	.....	.....	(a)(b)	(a)(b)
Cement, barrels	.....	.....	c 9,634,582	c $7,237,591	.....	.....	c 10,219,492	c $10,218,867
Clay products, short tons	82,035	b $71,391	.....	7,935,251	74,581	b $70,929	.....	8,498,646
Coal, short tons	15,285,718	17,480,546	.....	.....	17,165,671	19,001,881	.....	.....
Coke, do	.....	.....	2,616,339	b 12,528,685	.....	.....	2,727,025	b 13,182,136
Gems and precious stones	.....	.....	.....	100	.....	.....	.....	100
Iron, pig, long tons	.....	.....	(a)(b)	(a)(b)	.....	.....	(a)(b)	(a)(b)
Lime, short tons	.....	.....	98,086	329,893	.....	.....	96,359	323,905
Mineral paints, natural pigments, short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold	993,163	677,718	.....	.....	383,577	205,621	.....	.....
Natural gas	.....	1,014,295	.....	.....	.....	948,278	.....	.....
Oilstones	.....	.....	.....	19,715	.....	.....	.....	(a)
Petroleum, barrels	970,009	885,975	.....	.....	956,095	1,279,226	.....	.....
Pyrite, long tons	1,462	5,684	.....	.....	1,242	3,115	.....	.....
Sand and gravel, short tons	4,701,005	1,175,370	.....	.....	5,021,878	1,260,672	.....	.....
Sand-lime brick	.....	.....	.....	59,929	.....	.....	.....	58,550
Stone	.....	(d)	.....	d 5,091,924	.....	(d)	.....	d 4,676,689
Sulphuric acid (60° Baumé), e short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Miscellaneous	.....	.....	.....	17,495,437	.....	.....	.....	20,761,060
Total value, eliminating duplications	$42,239,193				$46,607,864			

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of natural cement, value for which is included under "Miscellaneous."
d Stone sold rough included in derived product.
e From zinc smelting.

IOWA.

The principal mineral industries of Iowa are coal mining and clay working, and these two contributed nearly 80 per cent of the total mineral value, which in 1913 amounted to $25,602,015, the value of the coal and clay products combined being $19,070,391. In 1912 the total value of the mineral production of Iowa was $22,900,350, of which the coal mines and the clay pits contributed $17,674,414. Coal is mined in 22 different counties, of which the principal ones are Monroe, Polk, Appanoose, Dallas, and Mahaska in the order named. The coal-mining operations are conducted chiefly on a moderate scale, there being but 18 mines with a production in excess of 100,000 tons and only 6 with a production of over 200,000 in 1913. Iowa is primarily an agricultural State, and the markets for its coal, outside of that taken by the railroads, are chiefly in rural communities and cities of moderate size depending on the agricultural trade. For this reason the industry has not shown the same progress as in many of the other Western States. In the thirty-odd years that reports of the mineral production of the United States have been published by

the Geological Survey the coal production of Iowa has increased barely 100 per cent. In 1882, the first year for which the statistics were collected by the Geological Survey, Iowa produced 3,920,000 tons, a little more than one-half of the output in 1913, whereas the total production of coal in all of the Western States is now about 10 times what it was 30 years ago. Iowa ranks tenth among all the States and second among the States west of Mississippi River in the production of coal. It ranks eighteenth in the value of its manufactures and twenty-second in the total value of its mineral output. The production of coal in Iowa increased from 7,289,529 short tons, valued at $13,152,088, in 1912, to 7,525,936 tons, valued at $13,496,710 in 1913, the slight increase being due to the labor troubles in Colorado which cut down the supply in that State.

The clay-working industries in 1913 showed a decided improvement over the preceding year, the value of the products showing a gain of over $1,000,000, from $4,522,326 in 1912 to $5,573,681 in 1913. The chief products are drain tile and common brick. In the manufacture of drain tile Iowa holds first place among all the States. The principal clay-working counties are Webster, Cerro Gordo, Polk, and Woodbury. Third in importance among the State's mining industries is the manufacture of Portland cement, and in this also the output in 1913 showed an increase of over $1,000,000 in value, the output in that year being 3,455,800 barrels, valued at $3,972,876, compared with 3,190,354 barrels, valued at $2,790,396, in 1912. The State has three modern cement plants of large capacity and possesses an abundance of excellent raw material for cement manufacture. The increased production in 1913 followed an increase in 1912 of 63 per cent in quantity and 48 per cent in value over the output of 1911. The value of the cement produced in Iowa in 1913 was more than double that of 1911. Another notable increase was made in the production of gypsum, a branch of the mining industry in which Iowa holds second place among the States. The value of the gypsum products of Iowa in 1913 was $1,157,939, an increase of more than $300,000 over 1912, when they were valued at $845,628. The gypsum industry is centered about Fort Dodge in Webster County, and the gypsum is sold principally as calcined plaster. An increase from 2,231,615 short tons in 1912 to 2,698,032 in 1913 was shown in the production of sand and gravel, but the value of this output decreased from $562,809 to $528,066. A decrease was also shown in the value of the stone produced, from $946,436 to $805,294. These decreases are due to the completion of the Keokuk Dam by the Mississippi Power Co., the construction of which had caused considerable increase in the stone production of Iowa in 1912. The principal producing counties are, in the order named, Scott, Marshall, Jones, Lynn, and Dubuque. Most of the stone outside of that used in the construction of the Keokuk Dam is used in the manufacture of concrete and for railroad ballast. The other commercial mineral products are lead, lime, mineral paints, mineral waters, natural gas, and sand-lime brick, but all these together represent less than $100,000 in value.

The distribution of the production in 1912 and 1913 by substances is shown in the following table:

Mineral production of Iowa in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel, short tons	.....	.....	(a) (b)	(a) (b)	.....	.....	.....	.....
Cement.....barrels	.....	.....	3,190,354	$2,790,396	.....	.....	3,455,800	$3,972,876
Clay products, short tons	7,192	b $2,166	.....	4,522,326	2,655	b $1,900	.....	5,573,681
Coal.....short tons	7,289,529	13,152,088	.....	.....	7,525,936	13,496,710	.....	.....
Gypsum.....do	411,186	.....	.....	845,628	456,031	.....	.....	1,157,939
Lead.....do	.....	.....	63	5,670	.....	.....	65	5,720
Lime.....do	.....	.....	12,935	51,800	.....	.....	10,015	47,520
Mineral paints, natural pigments, short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold	84,300	11,375	.....	.....	48,665	7,369	.....	.....
Natural gas	.....	120	.....	.....	.....	120	.....	.....
Sand and gravel, short tons	2,231,615	562,809	.....	.....	2,698,032	528,066	.....	.....
Sand-lime brick	.....	.....	.....	(a)	.....	.....	.....	(a)
Stone	.....	(c)	.....	c 946,436	.....	(c)	.....	c 805,294
Miscellaneous	.....	.....	.....	13,702	.....	.....	.....	6,720
Total value, eliminating duplications	$22,900,350				$25,602,015			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

KANSAS.

The total value of the mineral production of Kansas in 1913 amounted to $27,312,563, against $26,554,967 in 1912. The principal products are coal and natural gas, though the latter has fallen off steadily since 1909, and in 1913 had a value exceeding that of Portland cement by less than $2,000. Nearly 45 per cent of the total value is represented by the output of the coal mines, which in 1912 amounted to 6,986,182 short tons, valued at $11,324,130, and in 1913 to 7,202,210 tons, valued at $12,036,292. The coal-producing area is entirely in the eastern part of the State, and more than 90 per cent of the total production is from two counties, Cherokee and Crawford, in the extreme southeast corner. Leavenworth and Osage counties are also producers of some importance, the output in the former being largely from one property at Leavenworth, whereas in Osage County the production is from numerous small operations supplying relatively local trade. An interesting development in 1913 was the application of steam shovels to the stripping operations.

The production of natural gas in 1913 was valued at $3,288,394, a decrease from $4,264,706 in 1912. Some natural gas was produced in Kansas as early as 1886, but there was little in the way of real development until the latter part of the century, when considerable drilling was done in Allen, Labette, Montgomery, Miami, and Wilson counties. The Iola gas field in Allen County promised to develop into an important source of natural gas, and in 1903 the value of the gas produced in Kansas exceeded $1,000,000, continuing to increase until 1909 when it amounted to $8,293,846, Kansas having become by

this time the fourth in the Union in the production of natural gas. Since 1909, however, the production has declined almost in the same ratio in which it advanced, and in 1913 it was less than in any year since 1905. The industries established in and around Iola which were formed on the basis of the supply of natural gas now draw their fuel gas from Oklahoma, which has taken the place of Kansas in the rank of gas-producing States and in 1913 had a production slightly exceeding that of Kansas in 1909. The quantity of gas produced in Kansas in 1909 was 75,000,000,000 cubic feet; in 1913 it was 22,884,547,000 cubic feet.

From 1909 to 1912 the manufacture of Portland cement followed somewhat the production of natural gas, the cement industry having been developed because of the cheap and apparently abundant supply of gas. The year of maximum production of cement was in 1910, when the output of Portland cement amounted to 5,655,908 barrels, valued at $5,359,408. In 1912 the production of Portland cement amounted to 3,592,148 barrels, valued at $2,815,113; it decreased to 3,291,818 barrels in 1913, but the value increased to $3,286,861. A small quantity of natural cement is also made in the State. The value of the clay products has also declined in each of the last three years. In 1910 the value of the clay products, exclusive of pottery, was $2,661,527, and in 1913 it was $1,919,910. The principal product from the clay-burning kiln is vitrified brick, in the production of which Kansas ranks fourth among the States. The principal counties in the manufacture of vitrified brick are Montgomery, Wilson, and Crawford. Wilson County is the largest producer of common brick, with Allen second and Montgomery third. The mineral product which showed the most significant gain in 1913 is petroleum, which increased from 1,592,796 barrels, valued at $1,095,698, in 1912 to 2,375,029 barrels, valued at $2,248,283, in 1913, the increase amounting to 49 per cent in quantity and 105 per cent in value. The leading counties in the production of petroleum are Chautauqua, Montgomery, Neosho, and Allen.

Sixth among the mining industries of Kansas is the production of zinc ores, the recoverable metallic content of which in 1913 amounted to 10,088 short tons, valued at $1,129,856, a decrease from 10,633 tons, valued at $1,467,354, in 1912. Other important mining industries in Kansas are salt mining and evaporating, stone quarrying, and the mining and calcining of gypsum. In the production of salt Kansas ranks fourth among the States. In quantity of output the rock and evaporated salt produced in Kansas were about equal, the former amounting in 1913 to 1,351,721 barrels and the latter to 1,346,358 barrels, but in value the evaporated salt is more than two and a half times that of the rock salt, these values for 1913 being, respectively, $624,852 and $235,552. Quarry products in 1913 were valued at $825,607, against $763,228 in 1912. The less important mineral products of Kansas are occasional gems, lead, lime, mineral paints, mineral waters, pumice, sand and gravel, sand-lime brick, and sulphuric acid from zinc smelting.

The distribution of the mineral production of Kansas in 1912 and 1913, by substances, is shown in the following table:

Mineral production of Kansas in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	.....	.....	[a] 3,592,148	[a]$2,815,113	.....	.....	[a]3,291,818	[a]$3,286,861
Clay products.....	.....	.....	.....	[b]2,036,500	.....	.....	.....	[b]1,919,910
Coal.....short tons..	6,986,182	$11,324,130	.....	.....	7,202,210	$12,036,292	.....	.....
Coke.....do....	.....	.....	(c) (d)	(c) (d)	.....	.....	.....	.....
Gems and precious stones.....	.....	.....	.....	.....	.....	.....	.....	30
Gypsum.short tons..	131,031	.....	.....	324,820	110,510	.....	.....	308,308
Lead.....do....	.....	.....	2,371	213,390	.....	.....	2,427	213,576
Lime.....do....	.....	.....	232	1,131	.....	.....	(c)	(c)
Mineral paints, zinc-lead pigments, short tons.....	.....	.....	(c)	(c)	.....	.....	(c)	(c)
Mineral waters, gallons sold.....	428,677	75,919	.....	.....	337,193	60,026	.....	.....
Natural gas.....	.....	4,264,706	.....	.....	.....	3,288,394	.....	.....
Petroleum...barrels..	1,592,796	1,095,698	.....	.....	2,375,029	2,248,283	.....	.....
Pumice..short tons..	(c)	(c)	.....	.....	(c)	(c)	.....	.....
Salt.....barrels..	1,244,014	229,805	1,329,612	614,487	1,351,721	235,552	1,346,358	624,852
Sand and gravel, short tons.....	1,381,586	287,352	.....	.....	1,119,990	271,509	.....	.....
Sand-lime brick.....	.....	.....	.....	(c)	.....	.....	.....	(c)
Stone.....	.....	(e)	.....	e 763,228	.....	(e)	.....	e 825,607
Sulphuric acid (60° Baumé), f short tons.....	.....	.....	(c)	(c)	.....	.....	(c)	(c)
Zinc.....short tons..	.....	.....	10,633	1,467,354	.....	.....	10,088	1,129,856
Miscellaneous.....	.....	(e)	.....	e1,044,209	.....	(e)	.....	e 863,507
Total value, eliminating duplications..	$26,554,967				$27,312,563			

[a] Exclusive of natural cement, value for which is included under "Miscellaneous."
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] Value not included in total value.
[e] Raw product included in derived product.
[f] From zinc smelting.

KENTUCKY.

The principal mineral product of Kentucky is coal, the value of which constitutes about three-fourths of the State's total mineral output. In 1913 the total value of the mineral production of Kentucky approximated $27,000,000, of which the coal mines contributed $20,516,749. Kentucky is the only one of the coal-producing States which has within its borders areas belonging to any two of the great coal fields. The coal beds in the eastern part of the State belong to the Appalachian system, whereas those in the western part of the State belong to the eastern interior field, the larger part of which lies on the northern side of Ohio River in Illinois and Indiana. Up to the close of 1911 the larger part of the production had been from the western area, although the eastern fields are of greater extent and the coal of a higher quality. In 1912, as the result of extensive developments in Harlan, Johnson, Letcher, and Pike counties, the eastern part of the State showed a marked increase in production over the preceding year, and for the first time in the history of the State the total production of the eastern counties exceeded that of the western counties. The lead acquired in 1912 was increased by the record of 1913, and there is little probability that the western

district will again attain the supremacy. The total production of coal in Kentucky amounted in 1913 to 19,616,600 short tons, valued at $20,516,749, against 16,490,521 tons, valued at $16,854,207, in 1912. The increase in quantity amounted to 3,126,079 short tons, or 19 per cent, and the value increased $3,662,542, or 22 per cent. Nearly 80 per cent of the increase was in the eastern counties. Letcher County showed a gain of over 900,000 tons, and Pike County an increase of nearly 720,000. Harlan County, also in the eastern part of the State, showed a gain of nearly 420,000 tons. Three of these counties, it will be noted, are those in which the developments began as late as 1912. Other important producing counties in the eastern part of the State are Bell, Whitley, Johnson, Knox, McCreary, Floyd, and Laurel. Only one county—Bell—has a production in excess of 2,000,000 tons. The largest producers in the western district are Hopkins and Muhlenberg (both of which produce more than 2,000,000 tons annually), and Webster, Ohio, Union, Henderson, and McLean. In 1913 the eastern counties produced 11,098,960 short tons, against 8,617,193 tons in 1912, and the western counties 8,517,640 tons, against 7,873,328 tons in 1912.

In comparison with more than $20,000,000 in 1913, as represented by the coal production, the second industry in importance (clay working) contributes less than $3,000,000 in the value of its output. The principal products are fire brick and other forms of refractory material made from fire clay, and common brick. The principal producing counties are Jefferson, Carter, Kenton, and Boyd. Flint and plastic clays occur also in Greenup, Lewis, Butler, Rockcastle, Rowan, Wolfe, and other counties in the eastern part of the State. Refractory clays occur in Greenup and Livingston counties and in a number of counties west of Tennessee River. Potter's clay occurs in Ballard, Butler, Fulton, Hardin, Hickman, Madison, McCracken, and Marshall counties, and ball clay is produced in Graves County. The total value of the manufactured clay products in 1913 was $2,914,276, an increase of $470,536 over 1912. The total quantity of raw clay produced and sold was 91,114 short tons, valued at $113,871, against 91,097 short tons, valued at $93,560, in 1912.

The quarrying industry is third in importance, with products in 1913 valued at $1,150,205, against $1,282,148 in 1912. The principal product is limestone, most of which is crushed for road making, railroad ballast, and concrete. Limestone for iron flux is quarried in Boyd, Carter, Kenton, and Rockcastle counties, and limestone for lime burning in Christian, Hardin, Knott, Rockcastle, and Union counties. Oolitic limestone is quarried in Warren County. Ordinary limestone is widely distributed and quarried in many counties of the State, principal among which are Warren, Christian, Jefferson, Caldwell, and Jessamine. The principal producers of sandstone, or freestone, in small quantities, are Bell, Breckinridge, Knox, Logan, and Muhlenberg.

The production of petroleum in Kentucky increased from 484,368 barrels, valued at $424,842, in 1912 to 524,568 barrels, valued at $675,748, in 1913, while the value of the natural gas produced decreased from $522,455 to $509,846. The principal petroleum-producing counties are Barren, Bath, Floyd, Knott, Lawrence, Logan, Ohio, Rowan, Wayne, and Wolfe.

Kentucky is one of the few States in which fluorspar is produced, and in 1913 the output was nearly double in quantity and value that of 1912. It is mined in Crittenden and Livingston counties. Some barytes has been produced in Kentucky, but no output was reported in 1913. The other mineral products are asphalt, cement, iron ore, lead, lime, mineral waters, oilstones, sand and gravel, sand-lime brick, and zinc; and of these only one exceeded $100,000 in value in 1913—sand and gravel. The total value of the mineral products of Kentucky increased from $22,477,530 in 1912 to $26,845,579 in 1913, and the distribution by substances for the two years is shown in the following table:

Mineral production of Kentucky in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt....short tons..	(a)	(a)			(a)	(a)		
Cement.....barrels..			(a)	(a)			(a)	(a)
Clay products, short tons.....	91,097	b $93,560		$2,443,740	91,114	b $113,871		$2,914,276
Coal.....do....	16,490,521	16,854,207			19,616,600	20,516,749		
Coke.....do....			191,555	b 513,734			317,084	b 753,897
Ferro-alloys, long tons..			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Fluorspar..short tons..	(a)	(a)			19,622	113,903		
Iron ore.....long tons..	(a)	(a)			(a)	(a)		
Iron, pig.....do....			77,578	b1,221,161			59,071	b 950,484
Lead.....short tons..			106	9,540			22	1,936
Lime.....do....			3,397	11,577			6,001	24,313
Mineral waters, gallons sold.....	477,341	56,555			475,675	53,334		
Natural gas.....		522,455				509,846		
Oilstones.....				(a)				(a)
Petroleum ....barrels..	484,368	424,842			524,568	675,748		
Sand and gravel, short tons.....	778,241	391,477			1,137,286	424,049		
Sand-lime brick.....				(a)				(a)
Stone.....		(c)		c1,282,148		(c)		c1,150,205
Zinc.....short tons..			491	67,758			327	36,624
Miscellaneous.....		121,308		1,032,838		43,850		1,035,229
Total value, eliminating duplications.....		$22,477,530				$26,845,579		

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

LOUISIANA.

Since 1904, when the Frasch process for the recovery of sulphur was put in operation in Louisiana, that State has stood preeminently in the lead as a producer of this mineral, and in the 10 years from 1904 to 1913, inclusive, approximately 3,000,000 tons of refined sulphur have been recovered. Prior to 1904 the source of sulphur in quantity in the United States was iron pyrite, from which sulphuric acid is made direct. Nearly all of the sulphur used was imported from Sicily, though small quantities have been produced in Utah and Nevada. The Nevada and Utah deposits are no longer active, but a small quantity of sulphur is now produced in Wyoming, and during 1913 the production of sulphur was begun in quantity in Texas by a process similar to the one in operation in Louisiana. In 1903, one year before the

production of sulphur in Louisiana began to exert an influence on the market, the imports of sulphur (crude and refined) amounted to 191,033 long tons, valued at $3,709,690, and the domestic production was less than 5,000 tons. In 1913 the marketed production of domestic sulphur was 311,590 long tons, valued at $5,479,849, most of which was from Louisiana, and the imports amounted to only 22,605 tons, valued at $448,564. The marketed production of domestic sulphur in 1913 was approximately 15 times the imports, which now exert relatively no influence in the American markets. Although since 1904, and until the developments in Brazoria County, Tex., in 1913, Louisiana has had almost a practical monopoly in the production of sulphur in the United States, sulphur mining is not the chief source contributing to the mineral wealth of the State. Two years before the development of the sulphur resources at Sulphur City prospecting for petroleum in the vicinity of Jennings resulted in the discovery and development of several important oil pools. During the decade which followed the discovery at Jennings, other productive areas have been developed in several portions of the State, and now Louisiana ranks fifth among the States in the quantity of oil produced and eighth in the value of the product. Prior to the oil developments in 1902 and the beginning of the sulphur production in 1904, Louisiana could hardly be considered as having any claim to recognition as a mining State. In the report on the production of sulphur in 1913 the total marketed production is given as 311,590 long tons, most of which was from Louisiana, but the State figures may not be published because of the necessity for maintaining the confidential character of individual reports. The quantity of sulphur actually produced was considerably in excess of that marketed in both 1912 and 1913, but as the reports of the Survey are based upon the marketed output and not upon the quantity actually mined, the sulphur held in stock at the end of 1912 and 1913 is not included in the production of these years. During the 10 years of oil and sulphur production, however, Louisiana has increased the value of her mineral products from less than $1,000,000 at the beginning of the present century to over $21,000,000 in 1913. In the first two years of oil development the production did not amount to 1,000,000 barrels in either year, but in 1904, the year in which the sulphur industry asserted itself, the output of petroleum approximated 3,000,000 barrels, and in 1905 this output was trebled. In 1911 the production of petroleum amounted to 10,720,420 barrels, valued at $5,668,814; it decreased to 9,263,439 barrels in 1912, but the value increased to $7,023,827. In 1913 both the production and the value increased markedly, the former to 12,498,828 barrels and the latter to $12,255,931, the increase in production in 1913 over 1912 being 3,235,389 barrels, or 35 per cent, and the increase in value $5,232,104, or 74 per cent. The average value per barrel for Louisiana petroleum has advanced from 52.9 cents in 1911 to 75.8 cents in 1912 and to 98 in 1913. In the 10 years of the production of petroleum in Louisiana the activities have shifted from the southern to the northern part of the State, and the larger part of the production at present is from the Caddo district, near Shreveport, in the northwestern part of the State. Acadia and Calcasieu parishes are the principal producers in the southwestern part. There is good reason to believe that Louisiana is underlain by one of the greatest gas fields in the United States, but its development on a large scale must

await the establishment of manufacturing industries which will provide for its utilization, or it must be transported by pipe lines to distant points for consumption. Through the influence and under the advice of the Louisiana Conservation Commission the gas and oil producers of Louisiana have taken effectual steps to minimize the waste in natural gas to which references are made in the report for 1912.

During the last two or three years there has been considerable development of natural gas in Louisiana, and the production of this fuel in 1913 exceeded $2,000,000. The natural gas developments are all in the vicinity of Caddo.

In addition to its production of petroleum and sulphur Louisiana is also an important producer of rock salt, in value of which it ranks second among the States. The salt mines underlie so-called islands which are really mounds rising from the marsh lands along the Gulf coast in Iberia Parish. Some of the first rock salt mined in the United States was from the Petite Anse mines on Avery Island, which were opened in 1862 and operated during the Civil War until the works were destroyed by the Federal troops. Earlier attempts at utilizing the salt deposit by dissolving the salt and evaporating by boiling were not successful. Mining on Weeks Island was begun in 1902. In the total production of salt, which includes the product from brine, Louisiana ranks sixth as to value among the States.

Louisiana's clay products, exclusive of pottery, were valued at $638,491 in 1913, compared with $523,643 in 1912. The one other mining industry of any importance is that represented by the sand and gravel pits, which furnished 878,943 short tons, valued at $262,840, in 1913, against 933,617 tons, valued at $417,041, in 1912. A small quantity of stone is produced and some commercial mineral waters are sold in the State. The total value of the mineral products of Louisiana showed an increase of nearly 37 per cent, from $15,357,841 in 1912 to $21,011,828 in 1913.

The mineral production of the State in 1912 and 1913, distributed by substances, is shown in the following table:

Mineral production of Louisiana in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				[a] $523,643				[a] $638,491
Mineral waters, gallons sold	561,660	$33,345			700,795	$39,657		
Natural gas		(b)				(b)		
Petroleum ..barrels	9,263,439	7,023,827			12,498,828	12,255,931		
Salt.....do	(b)	(b)			(b)	(b)		
Sand and gravel, short tons	933,617	417,041			878,943	262,840		
Stone		(c)		(a)		(c)		(a)
Sulphur...long tons	(b)	(b)			(b)	(b)		
Miscellaneous		7,289,753		70,232		7,726,757		88,152
Total value, eliminating duplications	$15,357,841				$21,011,828			

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Stone sold rough included in derived product.

MAINE.

The commercial mineral products of Maine are, considering the size and population of the State, few in number and of minor importance in character and value of output. In the value of one mineral substance, feldspar, Maine has ranked first during the last three years, and in 1913 its output of that material showed an increase of more than 100 per cent, in both quantity and value, over that of 1912. The principal mineral product of the State is granite, in which Maine ranks third among the States of the Union, being exceeded only by Vermont and Massachusetts, both of them also New England States. More than half of the granite quarried is used for building and monumental purposes, but considerable quantities are made into paving blocks and curbing, and a relatively small quantity—chiefly waste—is crushed and screened for road making, concrete, and railroad ballast. The granite quarries are located principally in Franklin, Hancock, Kennebec, Knox, and Waldo counties, and in 1911 and 1912 they contributed nearly one-half of the total mineral production of the State; but the decreased value of the stone output in 1913 and the largely increased production of lime, feldspar, and clay products reduced the relative importance of the quarrying industry. The total value of the stone production in 1913 was $1,792,079 against $1,810,590 in 1912. The principal limestone quarries are in Knox County, and the product is used chiefly in the manufacture of lime, although some limestone is also shipped for fluxing purposes. The quantity of lime produced in 1913 was a little less than in 1912, but the value increased from $644,255 to $906,604. Maine is also one of the leading States in the production of slate, which is quarried in Piscataquis County. The product was valued at $282,678 in 1912 and at $323,998 in 1913. As already stated, the production of feldspar, in which Maine leads, was in 1913 double that in 1912, the figures for the two years being, respectively, 38,248 short tons, valued at $347,499, and 19,091 tons, valued at $173,076. The only other commercial minerals produced in Maine in 1913 were mineral waters, sand and gravel, and a small quantity of gem material.

The total value of the mineral products of Maine in 1912 and 1913, distributed by substances, is shown in the following table:

Mineral production of Maine in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products	.....	.....	.....	$540,101	.....	.....	.....	$666,573
Feldspar, short tons	19,091	$173,076	.....	.....	38,248	$347,499	.....	.....
Gems and precious stones	.....	.....	.....	15,100	.....	.....	.....	820
Lime, short tons	.....	.....	155,559	644,255	.....	.....	146,970	906,604
Mineral waters, gallons sold	1,179,192	432,765	.....	.....	1,174,262	368,436	.....	.....
Sand and gravel, short tons	34,372	26,961	.....	.....	48,963	23,575	.....	.....
Slate	.....	.....	.....	282,678	.....	.....	.....	323,998
Stone	.....	(a)	.....	a1,810,590	.....	(a)	.....	a1,792,079
Total value, eliminating duplications	$3,925,526				$4,429,584			

a Stone sold rough included in derived product.

MARYLAND.

The coal production of Allegany and Garrett counties, in the western part of the State, constitutes something more than half of the total value of Maryland's mineral production. Coal mining began in the State in the first quarter of the nineteenth century in the Georges Creek region, and the coal was shipped by barges on Potomac River. The first incorporated company was organized in 1836. Coal mining has remained practically stationary in Maryland during the last 10 years, and is now probably entering upon a period of decline which will continue until conditions warrant a more extensive development of the lower and thinner beds. In 1913, a year of generally increased coal production in the Eastern States, the output of the Maryland mines decreased, although the value of their output increased. The total production of coal in Maryland in 1913 was 4,779,839 short tons, valued at $5,927,046, compared with 4,964,038 tons, valued at $5,839,079, in 1912.

Second in importance among the mining industries of Maryland is clay working. The clays of the State are widely distributed and suitable for a variety of uses. In the Coastal Plain part of the State clays are largely used in the manufacture of building brick and terra cotta. In the western portion of the State carboniferous clays are used in the manufacture of a fire brick which is regarded as of the highest grade made in the United States. The total value of the clay products of Maryland in 1913 was $1,917,500, of which the value of the common brick manufactured in the vicinity of Baltimore was $725,435, and the value of the fire brick made in the western part of the State was $248,795. In 1912 the total value of the clay products was $1,865,753, of which the Baltimore common brick furnished $746,847, and the fire brick of western Maryland, $231,270.

Third in importance among the mineral industries of the State are the stone quarries, the value of whose output in 1913 amounted to $1,153,115 against $1,032,022 in 1912. The principal stone quarried is granite, the chief quarries being in Baltimore, Cecil, Harford, Howard, and Montgomery counties, and within the city limits of Baltimore. Baltimore County produces also a white marble extensively used for structural purposes in the city of Baltimore. Limestone is produced in considerable quantity in the western part of the State, some of it being used for building purposes. The output of limestone burned into lime is not included in the stone production. The quantity of limestone burned into lime is represented by 108,883 short tons of lime, valued at $357,392, in 1913, against 112,104 tons, valued at $365,037, in 1912. The production of sand and gravel increased from 1,650,904 short tons in 1912 to 1,821,214 tons in 1913, but the value decreased from $627,874 to $622,567. A part of the Peach Bottom slate belt of Pennsylvania is found in Harford County, and considerable operations are carried on. In 1913 the value of the slate produced in Maryland was $83,993, a decrease of nearly 9 per cent from that of the preceding year.

In Maryland, as in Delaware, iron-ore mining was at one time an industry of considerable relative importance, but it is now of an insignificant and intermittent character, and conducted principally by farmers in off seasons. Some copper ores have been mined, but only to a limited extent in recent years. None was produced in 1913.

The other commercial products of Maryland are cement, feldspar, infusorial earth, mineral paints, mineral waters, sand-lime brick, silica, silver, talc, and soapstone. The total value of the mineral products of the State in 1913 was $11,292,723, compared with $10,851,671 in 1912, distributed by substances as shown in the following table. If the value of the pig iron produced in Maryland (principally from imported ores) were included in the total value, the output would be increased by approximately 40 per cent.

Mineral production of Maryland in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel, short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Cement.....barrels	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons	25,279	[b] $36,687	.....	$1,865,753	24,829	[b] $36,955	.....	$1,917,500
Coal.....short tons	4,964,038	5,839,079	.....	.....	4,779,839	5,927,046	.....	.....
Coke.....do	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Copper.....pounds	.....	.....	(a)	(a)	.....	.....	.....	.....
Feldspar, short tons	9,231	55,998	.....	.....	16,702	82,833	.....	.....
Infusorial earth	.....	.....	.....	(a)	.....	.....	.....	(a)
Iron ore...long tons	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Iron, pig.....do	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Lime.....short tons	.....	.....	112,104	365,037	.....	.....	108,883	357,392
Mineral paints, natural pigments, short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold	1,606,373	157,541	.....	.....	1,390,437	126,883	.....	.....
Sand and gravel, short tons	1,650,904	627,874	.....	.....	1,821,214	622,567	.....	.....
Sand-lime brick	.....	.....	.....	(a)	.....	.....	.....	.....
Silica.....short tons	16,125	62,151	.....	.....	7,858	55,442	.....	.....
Silver, fine ounces (troy)	.....	.....	(a)	(a)	.....	.....	.....	.....
Slate	.....	.....	.....	92,184	.....	.....	.....	83,993
Stone	.....	[c]	.....	[c]1,032,022	.....	[c]	.....	[c]1,153,115
Talc and soapstone, short tons	[c]	[c]	(a)	(a)	[c]	[c]	(a)	(a)
Miscellaneous	.....	[c]	.....	[c]6,490,432	.....	[c]	.....	[c]6,605,212
Total value, eliminating duplications		$10,851,671				$11,292,723		

[a] Value included under "Miscellaneous."
[b] Value not included in total value.
[c] Raw product included in derived product.

MASSACHUSETTS.

The principal mineral products of Massachusetts, as in most of the New England States, are from the stone quarries and the clay pits. More than half of the total value of the mineral production is from the stone quarries, exclusive of the limestone burned into lime. The clay-working industries furnish approximately 25 per cent of the total production. The total value of the mineral products of Massachusetts in 1913 was $7,044,529, of which the stone quarries furnished $4,096,372, and the clay-working industries, $1,814,875. In 1912 the total value of the mineral production was $6,654,514, of which the stone quarries furnished $3,663,279 and the clay pits, $1,767,166.

About 60 per cent of the stone quarried, measured by value, was granite, of which the principal producing counties are Bristol, Essex, Middlesex, Norfolk, and Worcester, and in smaller quantities, Berkshire, Franklin, Hampshire, Hampden, and Plymouth. The granite quarried in Massachusetts is used chiefly for building and monumental purposes and for paving blocks, a relatively small quantity—principally the waste from the quarrying and stone-cutting operations—being used for road making, railroad ballast, and concrete. Trap rock is next to granite in value of output, Massachusetts being one of the half-dozen States in which the production of trap rock is an important industry. The value of the trap rock produced in the State in 1913 was about 70 per cent of that of the granite quarried. Trap rock is quarried principally in Essex, Hampden, Middlesex, and Suffolk counties. Sandstone is quarried in Bristol, Hampden, and Suffolk counties; marble in Berkshire and Hampden counties; and limestone in Berkshire, Middlesex, and Worcester counties.

The principal clay products are common brick and brick for stove lining. The leading counties in the production of common brick are Middlesex, Hampden, and Hampshire, in the order named, those counties furnishing more than half of the total number of common brick made in the State. Brick clay is also produced in Barnstable, Bristol, Dukes, Essex, Franklin, Plymouth, and Suffolk counties. Brick for stove lining is made from a fire clay dug principally at Fall River, in Bristol County. Some is produced also in Dukes County. Ordinary pottery clay is mined in Essex County and shipped to potteries outside the State. Plastic clay is abundant on Marthas Vineyard and in other portions of the State, but is not utilized. A small quantity of kaolin has been produced in Hampden County.

The lime-burning industry is centered in Berkshire County and is carried on independently of the marble-quarrying operations, but it is probable that a considerable quantity of the waste from the marble quarries finds its way to the limekilns. The production of lime in Massachusetts decreased from 144,384 short tons, valued at $738,597, in 1912 to 130,365 tons, valued at $683,541, in 1913. Massachusetts ranks eighth among the States in the quantity and value of lime, and in the total value of stone produced. The State produces no kind of mineral fuel, although numerous deposits of peat exist in swamps and bogs in the eastern and central portions. The metal production is confined to a small output of iron ore which is used in local furnaces. Other mineral substances which contribute to the total production of Massachusetts are emery, fuller's earth, occasional gems, diatomaceous (infusorial) earth, mineral waters, sand and gravel, sand-lime brick, silica, and talc. The distribution of the mineral products of Massachusetts, by substances, in 1912 and 1913, is shown in the following table:

Mineral production of Massachusetts in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products, short tons	1,350	a $2,678	.....	$1,767,166	843	a $1,807	.....	$1,814,875
Coke.....short tons	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Emery.....do	(b)	(b)	.....	.....	.....	.....	.....	.....
Fuller's earth..do	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Gems and precious stones	.....	.....	.....	700	.....	.....	.....	.....
Infusorial earth	.....	.....	.....	(b)	.....	.....	.....	.....
Iron ore...long tons	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Iron, pig.....do	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Lime.....short tons	.....	.....	144,384	738,597	.....	.....	130,365	683,541
Mineral waters, gallons sold	4,502,806	247,397	.....	.....	3,907,395	213,802	.....	.....
Sand and gravel, short tons	424,375	162,208	.....	.....	290,757	149,036	.....	.....
Sand-lime brick	.....	.....	.....	(b)	.....	.....	.....	42,149
Silica.....short tons	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Stone	.....	(c)	.....	c3,663,279	.....	(c)	.....	c4,096,372
Talc.....short tons	.....	.....	(b)	(b)	.....	.....	(b)	(b)
Miscellaneous	.....	34,054	.....	1,768,138	.....	35,254	.....	1,849,758
Total value, eliminating duplications	$6,654,514				$7,044,529			

a Value not included in total value.
b Value included under "Miscellaneous."
c Stone sold rough included in derived product.

MICHIGAN.

Michigan, eighth among the States in the value of its mineral production, owes its prominence as a mining State to its great wealth in two metals, iron and copper. It ranks second in the production of iron ore, being exceeded by Minnesota, and fourth in the production of copper, being exceeded by Arizona, Montana, and Utah. Among the less important branches of the mining industry it ranks first in the production of salt, bromine, calcium chloride, and sand-lime brick, second in the production of grindstones and manganiferous ore, and third in the production of gypsum. In 1911 and 1912, the value of the output considered, copper mining was the most important branch of the mining industry in Michigan, the recoverable copper content of the ore mined in 1912 being 218,138,408 pounds, valued at $35,992,837, whereas the iron ore production amounted to 12,797,468 long tons, valued at $29,003,163, the value of the copper in that year exceeding that of the iron ore by $6,989,674. In 1911 the recoverable copper had a value of $27,480,013, and the iron ore produced was valued at $23,810,710. In 1913, however, the copper-producing region of Michigan was the scene of a labor strife which put that State in the same class with West Virginia and Colorado, in the coal mines of which States a condition of warfare existed for a good part of the year, and in all three instances the struggles were for the recognition of the unions. As a result of the trouble in the copper mines of Michigan the output in 1913 was barely 60 per cent of that of 1912, the recoverable content of the ores mined being estimated at 135,853,409 pounds, valued at $21,057,278. The production of iron ore, on the other hand, uninterrupted by labor strife, decreased only slightly, from 12,797,468 long tons in 1912 to 12,668,560 tons, while the value showed decided gain of over $4,400,000 from $29,003,163 to $33,479,954. The increase in the value of the iron ore, however, was less than

one-third the decrease in the value of copper. The iron and copper mines of Michigan are in the upper peninsula and represent practically all of the mineral industry in that part of the State, and all of the metal mining in the entire State. The silver production reported from Michigan is a by-product of copper mining. The salt works, cement plants, coal mines, and other nonmetal producing establishments are almost altogether in the lower peninsula. The metal production of the upper peninsula under normal conditions represents about 80 per cent of the total value of the mineral products, and the nonmetals, chiefly from the lower peninsula, represent about 20 per cent of the total. The iron ores of Michigan, as of the other two States included in the Lake Superior region (Minnesota and Wisconsin) are hematites of Bessemer grade. They occur in the Marquette range, all of which is in Michigan, and the Menominee and Gogebic ranges, the larger portions of which are in Michigan, with smaller portions in Wisconsin. The principal producing counties are Marquette, Iron, Gogebic, and Dickinson. A relatively small quantity of ore comes from Baraga County. The value of the iron ores produced in 1913 represents 46 per cent of the total value of the mineral production of the State.

In 1882, the first year for which the volume of Mineral Resources was published, the Marquette and Menominee ranges were the only ones opened in the Lake Superior region. The production in the region in that year was a little short of 3,000,000 long tons, most of which was from Michigan. The Crystal Falls and Iron River districts began production in 1882, the first year covered by this review. These are not as important producers as the better-known districts, but each one is still turning out over a million tons yearly. The Gogebic range was opened in 1884, as was also the Vermilion range, in Minnesota. The Mesabi range, in Minnesota, now the greatest iron producer of the world, was opened in 1892, but Michigan continued to lead in the production of iron ore until the first year of the present century, its supremacy ceasing with 1900. At the present time two-thirds of the iron ore produced in the Lake Superior region is from the Mesabi range in Minnesota. A special chapter on the iron-ore reserves of Michigan, by C. K. Leith, was published in Mineral Resources for 1911.

The copper product of Michigan is largely native and is considered for some purposes superior to "electrolytic" copper. "Lake" copper, by which name the product of Michigan is generally known in the trade, sells generally about one-quarter cent per pound above other copper. The mining of copper in Michigan is of prehistoric origin, the metal having been used by the North American Indians before the advent of the white man. The development of copper mining, however, began in 1845, since which date up to the close of 1913, the production has amounted to somethiug over 5,335,000,000 pounds, or about 30 per cent of the total output of the United States. The mining operations are confined to Houghton and Keweenaw counties, the former being by far the more important.

Michigan stands well up in the list of States in the manufacture of cement, and cement making is third in value among the State's mineral industries. The production in 1913 showed a substantial increase, from 3,651,094 barrels in 1912 to 4,081,281 barrels in 1913, while the value increased from $3,145,001 in 1912 to $4,228,879 in

1913. The gain in output was 430,187 barrels, or 12 per cent, and in value $1,083,878, or 34 per cent. In the quantity and value of salt production Michigan and New York have frequently alternated as first in rank, Michigan having had the place of honor in each of the last three years. The salt works of the State were formerly by-plants of the lumber industry and used the sawmill waste for fuel. The decline in the lumber industry and the scarcity of wood for fuel have probably caused the salt works to turn to coal as a fuel and thereby influenced the coal production of the State. The salt production of Michigan (exclusive of rock salt), amounted to 10,829,307 barrels, valued at $3,054,532 in 1913, against 10,271,715 barrels, valued at $2,743,389, in 1912. In the days when salt making was subsidiary to the lumber industry the plants were largely located along the lake shore in Bay and Saginaw counties. The lake-shore plants have disappeared, but salt making is still to a considerable extent subsidiary to other industries, whereas lumber is the primary industry in and about Manistee and Ludington. Bay and Saginaw counties, on the shores of Saginaw Bay in the eastern part of the State, which were formerly of such importance, are now relatively insignificant. The principal producing districts are in St. Clair, Wayne, and Isabella counties. Some of the larger plants are subsidiaries of chemical companies.

The coal fields of Michigan occupy an isolated area in the lower peninsula. It is only within the present century that they have been developed to any extent, and such importance as the industry has is due to the decline of the lumber industry, as stated above. In the earlier years the refuse of the lumber mills furnished the principal fuel for the salt works, but the exhaustion of the forests and the decline of the lumber industry has created a demand for coal to supply the salt works and for the other manufacturing plants of the State. The production of coal in Michigan, however, has shown a declining tendency during the five years prior to 1913, because of the competition of higher-grade fuel from Ohio, Pennsylvania, and West Virginia. The maximum production of coal in Michigan was in 1907, when 2,035,858 tons were produced. It decreased each year until in 1912 the production amounted to only 1,206,230 tons. A slight increase to 1,231,786 tons, valued at $2,455,227, is shown in the production for 1913. The decrease in production noted above has been accompanied by a more pronounced decline in value, due principally to the use of automatic stokers by the manufacturing industries of the State and the utilization of coal "fines," and operators have had considerable difficulty in securing markets for the lump and better grades of coal which are sold chiefly for domestic use and which for this purpose make a satisfactory fuel. In winter the demand for lump coal exceeds the supply, but during the summer months the conditions are reversed.

There are two plants of by-product coke ovens in Michigan, one at Detroit and the other at Wyandotte, but most of the coal for both of these plants is obtained from the mines of West Virginia.

The principal clay products of Michigan are common brick and drain-tile, and the leading counties are Wayne, Eaton, Jackson, and Saginaw, in the order named. The value of the clay products increased slightly, from $2,545,498 in 1912 to $2,674,125.

The mining and calcining of gypsum is an industry of considerable importance in the State. There are three principal producing areas,

designated by the Michigan Geological and Biological Survey as the Grand Rapids-Grandville, in Kent County; the Alabaster, in Iosco County; and the St. Ignace, in Mackinac County. The production of gypsum increased from 384,297 short tons, valued at $621,547, to 423,896 short tons, valued at $721,325, in 1913.

The sand and gravel pits, which are distributed widely over the State, in 1912 produced 2,681,821 short tons, valued at $818,603, and in 1913, 6,424,168 short tons, valued at $1,529,142.

The principal quarry product is limestone, the value of which in 1913 was $1,408,708, out of a total value of stone produced of $1,520,133. In 1912 the total value of the stone produced in Michigan was $1,192,204, of which limestone contributed $1,139,560.

The other commercial mineral products are occasional gems, graphite (amorphous), lime, mineral paints, mineral waters, natural gas, petroleum, quartz (silica), scythestones, and silver (a by-product of copper mining). The total value of the mineral products in Michigan in 1913 was $72,143,211, against $80,062,486, distributed by substances as shown in the following table:

Mineral production of Michigan in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel, short tons			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Bromine..pounds			(a)	(a)			(a)	(a)
Calcium chloride, short tons			(a)	(a)			(a)	(a)
Cement....barrels			3,651,094	$3,145,001			4,081,281	$4,228,879
Clay products, short tons	2,043	b $6,173		2,545,498	1,710	b $6,504		2,674,125
Coal....short tons	1,206,230	2,399,451			1,231,786	2,455,227		
Coke.....do			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Copper....pounds			218,138,408	35,992,837			135,853,409	21,057,278
Gems and precious stones				1,432				400
Graphite, amorphous, short tons	(a)	(a)						
Grindstones				(a)				(a)
Gypsum, short tons	384,297			621,547	423,896			721,325
Iron ore..long tons	12,797,468	29,003,163			12,668,560	33,479,954		
Iron, pig.....do			459,975	b 6,579,048			447,188	b 6,568,920
Lime...short tons			74,720	311,448			77,088	331,852
Manganiferous ore, long tons	c 532,393	(c)			c 377,468	(c)		
Mineral paints, natural pigments, short tons			(a)	(a)			(a)	(a)
Mineral waters, gallons sold	1,420,465	75,611			884,893	52,642		
Natural gas		1,470				1,405		
Petroleum..barrels	(a)	(a)			(a)	(a)		
Salt.....do	(a)	(a)	10,271,715	2,743,389	(a)	(a)	10,829,307	3,054,532
Sand and gravel, short tons	2,681,821	818,603			6,424,168	1,529,142		
Sand-lime brick				316,732				321,245
Scythestones				(a)				(a)
Silica..short tons	(a)	(a)			(a)	(a)		
Silver, fine ounces (troy)			528,453	324,999			295,173	178,284
Stone		(d)		d 1,192,204		(d)		d 1,520,133
Miscellaneous		265,929		1,896,490		256,863		2,341,884
Total value, eliminating duplications		$80,062,486				$72,143,211		

a Value included under "Miscellaneous."
b Value not included in total value.
c Tonnage and value included in iron ore.
d Stone sold rough included in derived product.

MINNESOTA.

Minnesota far outranks all other States in the mining of iron ore, and during the last four years has contributed in both quantity and value considerably more than half of the iron ore produced and marketed in the United States. In 1913 the total marketed production of iron ore in this country was 59,643,098 long tons, valued at $130,905,558, of which Minnesota contributed 36,603,331 long tons, valued at $80,789,025. In 1912 Minnesota produced 34,249,813 long tons of iron ore, valued at $61,805,017. Minnesota's proportion of the marketed production of iron ore in 1913 was 61 per cent of the quantity and 62 per cent of the value. Because of its great wealth in iron ores and of their extended development, Minnesota ranks sixth among all of the States in the total value of its mineral production. When compared with the mining of iron ore, other branches of the mining industry in the State fall into insignificance. The value of the iron ore produced in the State represents considerably more than 90 per cent of the total output. By far the largest part of the iron-ore production is from the Mesabi iron range, which is now the most important iron-producing district in the world and lies entirely within the confines of the State of Minnesota. The Mesabi range is the youngest of the great iron ranges, having been opened in 1892, whereas the Gogebic and the Vermilion ranges were opened in 1884, the Menominee in 1877, and the Marquette range about 1854. In 1902, 10 years after it was opened, the Mesabi range produced nearly one-half of the entire iron-ore output of the Lake Superior region, and in 1903, 1 year later, accomplished that feat. In each of the last 10 years the Mesabi range has contributed more than all of the other ranges together, and the total production of the Mesabi range since 1892 has been nearly one-half that of the entire region. Of the total quantity of 38,658,793 tons of iron ore mined in Minnesota in 1913, the Mesabi range contributed 36,378,671 tons and reached the highest point in its history. The Vermilion range, one of the older producing districts, also lies within the State of Minnesota, but its production in 1913 (1,536,115 tons) was only a little more than 4 per cent of the output of the Mesabi range. The Cuyuna range did not ship ore until 1911, and, in 1913, 744,007 long tons were mined from that range. The quantity of iron ore mined in the State in 1913 was 38,658,793 long tons, but the marketed product of which the value is given was, as stated, 36,603,331 long tons.

Exclusive of the iron ore, the value of the mineral products of Minnesota in 1913 was $5,025,508, and in 1912, $4,867,712. The only two branches of the mining industry which contributed products exceeding $1,000,000 in value, outside of the iron mines, were the stone quarries and the clay pits. The principal quarry products are granite, limestone, and sandstone, and the leading counties in production are, for granite, Benton, St. Louis, Sherburne, and Stearns; for limestone, Blue Earth, Hennepin, Lesueur, and Winona; and for sandstone, Nicollet, Pine, and Pipestone. The value of the stone produced in 1913 was $1,952,686, against $1,845,746 in 1912. The clay products fell only slightly behind those of the quarries and amounted in 1913, exclusive of the value of the pottery, to $1,781,017, and in 1912 to $1,611,040. If the value of the pottery be added to the other clay products, the total would exceed by a good margin the value of the

stone produced. The principal clay product is common brick, with smaller quantities of sewer pipe, fireproofing, front brick, draintile, pottery, etc. Carver County is the principal producer of common brick, but in the total value of its clay products Goodhue County leads, with Hennepin County second. The pottery industry is centered around Red Wing, in Goodhue County. The other mineral products of Minnesota are cement, feldspar, occasional gems, lime, manganiferous ore, mineral waters, sand and gravel, and sand-lime brick. Distributed by substances, the mineral production of Minnesota in 1912 and 1913 is shown in the following table:

Mineral production of Minnesota in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons.....	(a) (b)	(a) (b)	.....	c$1,611,040	(a) (b)	(a) (b)	.....	c$1,781,017
Coke.....short tons..	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Feldspar.....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gems and precious stones.....	.....	.....	.....	400	.....	.....	.....	.....
Iron ore....long tons..	34,249,813	$61,805,017	.....	.....	36,603,331	$80,789,025	.....	.....
Iron, pig.....do....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Lime.....short tons..	.....	.....	44,063	269,841	.....	.....	22,800	112,300
Manganiferous ore, long tons.....	.....	.....	.....	.....	(d)	(d)	.....	.....
Mineral waters, gallons sold.....	8,881,018	252,277	.....	.....	4,802,053	183,759	.....	.....
Sand and gravel, short tons.....	946,339	278,578	.....	.....	2,094,910	282,882	.....	.....
Sand-lime brick.....	.....	.....	.....	112,785	.....	.....	.....	129,164
Stone.....	.....	(c)	.....	e1,845,746	.....	(c)	.....	e1,952,686
Miscellaneous.....	.....	33,720	.....	1,732,555	.....	30,800	.....	1,783,810
Total value, eliminating duplications..		$66,672,729				$85,814,533		

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of pottery, value for which is included under "Miscellaneous."
d Tonnage and value included in iron ore.
e Stone sold rough included in derived product.

MISSISSIPPI.

The utilization of some of its clay resources, the digging of sand and gravel, principally for building purposes, and the sale of some commercial mineral waters constitute the entire mineral industry of Mississippi. A small quantity of iron ore has been mined in the State and a few sand-lime brick were made in 1912, but there was no marketed production of iron ore nor any manufacture of sand-lime brick in 1913. Material suitable for the manufacture of cement, gypsum, marl suitable for fertilizer, ocher, and lignite beds are found in the State but have not been developed. The total value of the mineral products in Mississippi in 1913 was $1,143,472, against $1,242,528 in 1912. The clay products, 85 per cent or more of which is common brick, were valued at $641,271 in 1913, against $601,799 in 1912. The production of sand and gravel decreaed from 2,124,288 short tons, valued at $512,688, in 1912 to 1,891,663 short tons, valued at $420,401, in

1913, and the value of the mineral waters sold decreased from $126,241 in 1912 to $81,800 in 1913.

The statistics of the production during 1912 and 1913 are shown in the following table:

Mineral production of Mississippi in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products.....short tons..	.....	.....	.....	$601,799	(a) (b)	(a) (b)	.....	$641,271
Mineral waters...gallons sold..	639,905	$126,241	.....	.....	346,652	$81,800	.....	.....
Sand and gravel....short tons..	2,124,288	512,688	.....	.....	1,891,663	420,401	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	.....
Miscellaneous.....	.....	.....	.....	1,800	.....	14	.....	.....
Total value, eliminating duplications.....	$1,242,528				$1,143,472			

a Value included under "Miscellaneous."
b Value not included in total value.

MISSOURI.

Missouri leads all of the other States in the production of two important metals, zinc and lead, and in the production of a relatively unimportant nonmetal, barytes. It ranks second in the production of mineral paints and tripoli. The value of the lead and zinc content of the ores mined in Missouri represents nearly 60 per cent of the total value of the mineral products of the State. The mining and marketing of lead and zinc ores in Missouri is of a character peculiar to the State, in that the ores themselves, or rather the concentrates, are marketed products, and, strictly speaking, the basis of production should be the output and value of the concentrates, as that is the condition in which the product is first sold. In most of the metal-producing States, however, the only method of determining the value is on the metals themselves, principally because of the complex character of the ores which carry two or more of the metals, which are separated in the smelting and refining process. The lead ores of Missouri and of the other States of the Mississippi Valley carry so little silver that it is disregarded in the assay and sale of concentrate, and the lead produced from them is known to the trade as "soft lead." The output of lead concentrates decreased from 256,838 tons, valued at $11,948,358, in 1912, to 255,723 tons, valued at $11,444,935,in 1913. The concentrates of the zinc ore are of three kinds, sphalerite (zinc sulphide), zinc carbonate, and zinc silicate. The quantity of sphalerite marketed in 1913 was 225,850 short tons, valued at $9,180,960, against 244,986 tons, valued at $12,346,922 in 1912; and the carbonate and silicate concentrates amounted to 21,531 tons, valued at $483,463, against 22,172 tons, valued at $641,881, in 1912. The total value of the lead and zinc concentrates sold in 1913 was accordingly $21,109,358, against $24,937,161 in 1912. Based on the quantity and value of the metallic content the total production of lead and zinc

in Missouri in 1913 was $29,494,064, against $34,820,248 in 1912. The decrease in 1913 was almost entirely due to a smaller output of zinc ores, with a marked decline in the price of spelter. The recoverable zinc content of the ores produced in Missouri in 1913 amounted to 124,963 short tons, valued at $13,995,856, against 136, 551 tons, valued at $18,884,038, in 1912, indicating a decrease in value in 1913 of nearly $5,000,000, which was about the same as the increase in 1912 over 1911. The lead content of Missouri ores showed also a decrease, but only slight, from 177,069 short tons, valued at $15,936,210, to 176,116 tons, valued at $15,498,208. Missouri furnishes from 40 to 45 per cent of both the spelter and the lead produced in the United States. The principal lead-producing counties are St. Francois and Madison, in the eastern part of the State. In the Joplin district, which includes Jasper, Greene, Lawrence, and Newton counties in southwestern Missouri, Cherokee County in southeastern Kansas, and Ottawa County in eastern Oklahoma, lead is largely recovered as a by-product in zinc mining. Nearly all of the production of sphalerite ores (zinc sulphide) is in the Joplin district, but a considerable quantity of zinc silicate and carbonate ore is derived from mines in central and southeastern Missouri. The production in the Joplin district was affected somewhat similarly in 1913 as in 1911, when, owing to low prices for zinc ores a number of mines were shut down and the production fell off more than 12 per cent as compared with 1910. In 1913 the production decreased about 10 per cent in quantity and about 25 per cent in value.

Third in importance among Missouri's mineral industries is the mining of coal, the production of which decreased slightly, from 4,339,856 short tons, valued at $7,633,864, in 1912, to 4,318,125 tons, valued at $7,468,308, in 1913. Missouri ranks first in priority of coal production in the States west of Mississippi River, the census of 1840 showing a production in that year of 9,972 short tons, but in recent years the coal-mining industry has not shown the progress in Missouri that it has evinced in some of the other States of the Middle West. Missouri is practically surrounded by States in which coal is mined under more favorable conditions: Iowa on the north, Illinois and Kentucky on the east, Arkansas and Oklahoma on the south and southwest, and Kansas on the west. Competition with petroleum and natural gas in the Mid-Continent field of Oklahoma and Kansas has also had a retarding influence upon the development of Missouri's resources in coal. The coal-mining industry in the State during the last 10 years has been almost stationary, the output in 1912 being the maximum output ever attained, and the average for the last 10 years has been less than 3,850,000 short tons. The coal-producing areas lie entirely north and west of a line drawn from the northeast to the southwest corner of the State, and the principal coal-producing counties are Macon, Lafayette, Adair, Randolph, and Barton, in the order named.

The clay products are fourth in the value of Missouri's mineral output. While ranking seventh among the States in the total value of its clay products, it ranks second in the manufacture of fire brick, which is the principal clay product of the State. The principal center of the industry is in the immediate vicinity of St. Louis. The refractory brick made in Missouri are of especially high grade, and the average price of fire brick is higher than in any other State, with

the exception of New Jersey, in which the manufacture of fire brick is also an important industry. Ordinary brick clay is widely distributed and is utilized in nearly every county in the State. Fire clay is mined in Audrain, Boone, Callaway, Crawford, Franklin, Gasconade, Johnson, Linn, Montgomery, Morgan, Newton, Shelby, St. Louis, Stoddard, and Warren counties. Flint clays occur in a number of localities, but the only place in which they are mined at present is Osage County. Kaolin is mined at Bollinger, in Bollinger County; at Versailles, in Morgan County; and at Warren, in Warren County. Other pottery clays are found in Cass, Cooper, Franklin, Henry, Jasper, Jefferson (ball clay), Johnson, Linn, Livingston, Marion (pipe clay), Monroe, Ozark, Scott, Stoddard, Texas, and Vernon counties. The total value of the clay products increased from $6,412,861 in 1912 to $6,602,076 in 1913. Out of the total value in 1913, $2,138,368 was from the manufacture of fire brick, $1,270,581 from the manufacture of common brick, $1,213,889 from sewer pipe, and $480,372 from architectural terra cotta. Vitrified brick, front brick, drain tile, and fireproofing are also important clay products of the State. In fact, Missouri contributes something to each branch of the brick and tile industry as classified by the Geological Survey. In addition to the manufacture of clay products, the raw clay mined and sold in 1913 amounted to 238,032 short tons, valued at $470,277, against 295,701 tons, valued at $562,306, in 1912.

The production of Portland cement, which ranks fifth among Missouri's mining industries, decreased from 4,614,547 barrels in 1912 to 4,485,820 barrels in 1913, but increased in value from $3,700,776 to $4,556,822. The plants are located near St. Louis and Kansas City and also at Hannibal and Cape Girardeau, all but the one near Kansas City being along Mississippi River, in the eastern part of the State.

The quarry products, principally limestone, exhibited a slight increase in 1913, showing $2,538,699 in 1913 against $2,486,505 in 1912. Of these totals the limestone contributed $2,375,725 in 1912 and $2,486,020 in 1913. The principal limestone-producing counties are Jackson, St. Louis City, Jasper, St. Louis, and Clay, in the order named. Some granite is also quarried in the State, the principal operations being in Iron, St. Francois, and Carter counties.

The sand and gravel pits in 1913 yielded 4,126,126 short tons, valued at $1,109,233, against 3,687,380 tons, valued at $1,088,279, in 1912. Most of the sand and gravel produced is for the manufacture of concrete. In 1913 the sand used for building purposes was valued at $526,912, and the gravel, used largely for concrete, was valued at $232,831, the two representing about 70 per cent of the total value of the sand and gravel produced.

The production of lime increased from 148,885 short tons, valued at $721,896, in 1912 to 161,770 tons, valued at $734,009, in 1913.

The other mineral products of the State are copper, iron ore, mineral waters, natural gas, occasional gems, petroleum, pyrite, and silver. On account of the decreased value of the zinc production in 1913, the total value of the mineral products decreased from $58,332,550 in 1912 to $54,001,088 in 1913. The distribution of the production by substances in the two years is shown in the following table:

Mineral production of Missouri in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Barytes..short tons..	24,530	$117,035			31.131	$117,638		
Briquets, fuel..do....			(a)(b)	(a)(b)			(a)(b)	(a)(b)
Cement.....barrels..			4,614,547	$3,700,776			4,485,820	$4,556,822
Clay products, short tons.....	295,701	b562,306		6,412,861	238,032	b470,277		6,602,076
Coal.....short tons..	4,339,856	7,633,864			4,318,125	7,468,308		
Copper.....pounds..			440,725	72,719			576,204	89,312
Iron ore...long tons..	42,120	92,996			37,134	83,628		
Iron, pig.....do....			(a)(b)	(a)(b)			(a)(b)	(a)(b)
Lead.....short tons..			177,069	15,936,210			176,116	15,498,208
Lime.....do....			148,885	721,896			161,770	734,009
Mineral paints: Natural pigments, short tons.....			(a)	(a)				
Zinc-lead pigments, short tons.....			(a)	(a)			(a)	(a)
Mineral waters, gallons sold.....	608,385	81,114			697,467	84,316		
Natural gas.....		11,576				6,795		
Petroleum...barrels..					(a)	(a)		
Pyrite....long tons..	(a)	(a)			(a)	(a)		
Sand and gravel, short tons.....	3,687,380	1,088,279			4,126,126	1,109,233		
Silver, fine ounces (troy).....			35,438	21,794			35,620	21,514
Stone.....		(c)		c2,486,505		(c)		c2,538,699
Tripoli.....				75,569				83,995
Zinc.....short tons..			136,551	18,884,038			124,963	13,995,856
Miscellaneous.....		(c)		c1,369,933		20,679		1,347,839
Total value, eliminating duplications.	$58,332,550				$54,001,088			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

MONTANA.

Montana ranks tenth among the States in the total value of its mineral products, the chief industry being the mining and smelting of copper ores. As a producer of copper Montana ranks second among the States, with Arizona first. The center of the copper mining industry in Montana is, as is well known, in and around the city of Butte, Silver Bow County, with less important camps scattered through the southwestern part of the State. Reduction works are located at Butte, Anaconda, and Great Falls. A small quantity of copper was produced in Montana as early as 1868, but it was not until 1882 (the first year for which the report Mineral Resources of the United States was issued) that the industry began to assume importance. Development had begun in 1881, in which year the output of the then Territory amounted to 1,500,000 pounds; in 1882 the production exceeded 9,000,000 pounds, and in 1887 Montana had taken the first place among the States in the production of copper, displacing Michigan which for many years had been the premier State in this regard. In 1890 Montana's production of copper exceeded 100,000,000 pounds, and in 1896 it exceeded 200,000,000 pounds. Since 1907, with the exception of 1909, Montana has fallen behind Arizona as a copper producer. In its total production from the time

mining first began Montana exceeds any other State, its output to the close of 1913 amounting to nearly 6,200,000,000 pounds, somewhat more than one-third of the total production of the United States. In 1913 there was a general decrease in copper production as compared with 1912, Montana sharing in this decline to the extent of nearly 22,000,000 pounds, from 309,738,873 pounds in 1912 to 287,828,699 pounds in 1913. The value declined from $51,106,914 in 1912 to $44,613,448 in 1913.

Montana is essentially a metal-producing State, the value of its copper, silver, zinc, gold, and lead representing in 1913 over 89 per cent of its total production. It is also one of the important Rocky Mountain States in the production of coal. In the extent of its coal area Montana exceeds any other State of the Union with the possible exception of the lignite areas of Texas, about which relatively little is known.

In the production of silver Montana ranks second among the States, being exceeded in this regard by Nevada. The silver output of Montana is second in importance among its mineral products, and is obtained chiefly as a by-product in mining and smelting copper ores. In 1913, 10,326,364 fine ounces out of a total silver production of 13,819,201 ounces were taken from copper and copper-lead ores, and of this quantity Silver Bow County contributed over 98 per cent. About 10 per cent of the total production of silver is from dry or siliceous ores with relatively small quantity from zinc ore, lead ore, and placers. The second county in the production of silver is Jefferson, with Granite third. In spite of the decreased production of copper in 1913 the output of silver (based on the recoverable content of the ores mined and smelted) increased from 12,731,638 fine ounces, valued at $7,829,957, in 1912 to 13,819,201 fine ounces, valued at $8,346,797, in 1913.

The mining and smelting of zinc ores in Montana showed a marked increase in 1913 as compared with previous years, and zinc became third in importance among the metallic products of the State. The recoverable content of zinc in the ores mined in 1913 amounted to 44,337 short tons, valued at $4,965,693, and in 1912 the recoverable content of zinc amounted to 13,459 short tons, valued at $1,857,403. The production in 1913 was more than three times that of 1912 in quantity and more than two and one-half times in value. The entire production of zinc ores is from Silver Bow, Jefferson, and Fergus counties.

Gold production in Montana decreased slightly in 1913 from 175,371 fine ounces to 168,995 ounces; the value decreased in proportion from $3,625,235 to $3,493,432. The principal production of gold in Montana is from Madison County where dredging operations are carried on extensively. Placer mining of any kind is not practiced to any great extent in any other part of the State, although some dredging is carried on in Lewis and Clark, Powell, Missoula, and other counties; about 20 per cent of the gold production is obtained from copper ore mines in Silver Bow County. The chief counties in production of dry or siliceous ores from established mines are Fergus, Blaine, Broadwater, Lewis and Clark, Madison, and Jefferson, in the order named.

The only branch of the nonmetallic mineral industry which has been developed to any extent is coal mining, the principal operations

being in Carbon, Musselshell, and Cascade counties. In spite of decreased consumption of coal by the railroads, due to the increase in use of fuel oil and the extensive hydroelectric developments for supplying light and power to cities and to mining and manufacturing establishments, the production of coal in Montana increased from 3,048,495 short tons, valued at $5,558,195, in 1912 to 3,240,973 tons, valued at $5,653,539, in 1913. This increase is attributed to an enlarged demand for domestic fuel, which has followed the influx of settlers into the State, and has been sufficient to overcome the adverse influence previously mentioned.

Montana leads all the States in the production of precious stones, this supremacy being due to the mining of sapphire, one of the few instances of gem mining being carried on as a regular industry in the United States. The value of the gems produced in Montana increased from $200,585 in 1912 to $244,935 in 1913. The other commercial mineral products of the State are cement, clay products (principally common brick), grindstones, gypsum, iron ore, lime, mineral waters, sand and gravel, sand-lime brick, and stone.

On account of the decreased production of copper in 1913, the total value of the mineral products of the State showed a decrease from $71,620,873 to $69,307,056, the increase in other products not being sufficient to overcome the decrease in the output of copper. Distributed by substances the production of the State in 1912 and 1913 is shown in the following table:

Mineral production of Montana in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cement.....barrels	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons	4,200	b $4,657	.....	c $314,017	3,410	b $3,314	.....	c $456,897
Coal.....short tons	3,048,495	5,558,195	.....	.....	3,240,973	5,653,539	.....	.....
Copper.....pounds	.....	.....	309,738,873	51,106,914	.....	.....	287,828,699	44,613,448
Gems and precious stones	.....	.....	.....	200,585	.....	.....	.....	244,935
Gold, fine ounces (troy)	.....	.....	175,371	3,625,235	.....	.....	168,995	3,493,432
Grindstones	.....	.....	.....	(a)	.....	.....	.....	.....
Gypsum..short tons	(a)	.....	.....	(a)	(a)	.....	.....	(a)
Iron ore...long tons	(a)	(a)	.....	.....	2,475	7,425	.....	.....
Lead.....short tons	.....	.....	3,723	335,104	.....	.....	5,468	481,176
Lime.....do	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold	160,150	13,198	.....	.....	180,200	3,246	.....	.....
Sand and gravel, short tons	11,506	4,881	.....	.....	15,856	7,857	.....	.....
Sand-lime brick	.....	.....	.....	(a)	.....	.....	.....	.....
Silver, fine ounces (troy)	.....	.....	12,731,638	7,829,957	.....	.....	13,819,201	8,346,797
Stone	.....	(d)	.....	d 216,079	.....	(d)	.....	d 343,516
Zinc.....short tons	.....	.....	13,459	1,857,403	.....	.....	44,337	4,965,693
Miscellaneous	.....	(d)	.....	d 559,305	.....	.....	.....	689,095
Total value, eliminating duplications	$71,620,873				$69,307,056			

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of pottery, value for which is included under "Miscellaneous."
d Raw product included in derived product.

NEBRASKA.

Nebraska is primarily an agricultural State and has been designated as "the State without a mine." In the strict interpretation of what constitutes a mine this designation may be true. Nebraska does, however, contribute to the total mineral production by some utilization of its clay deposits, by the digging of sand and gravel, the quarrying of stone, the selling of commercial waters, the manufacturing of sand-lime brick, and in the production of volcanic ash or pumice.

In the production of pumice Nebraska holds an almost entire monopoly, less than 3 per cent of the total production of that substance being from other States. Considerably more than one-half of the total mineral production is from the clay pits, which furnished products in 1913 valued at $886,166, against $805,398 in 1912. The principal clay product is common brick with a smaller quantity of vitrified brick, front brick, draintile, fireproofing, etc. The clay resources have their greatest development in Douglas, Lancaster, and Adams counties, although clay suitable for the manufacture of ordinary brick occurs in practically every county in the State. Pottery clay has been dug in Cass County and also in Jefferson and Washington counties. The fire-clay deposits are found in the coal measure formation in the southeastern part of the State.

The coal beds in Nebraska are thin and have been worked only intermittently for local consumption; no production was reported from them in 1912 or 1913. The principal quarry production is limestone, most of which is crushed for use in manufacturing concrete. The principal producing counties are Cass, Gage, and Sarpy, and it is also found in workable quantity in Johnson, Nemaha, Otoe, and Cheyenne counties. The total value of the stone produced in the State decreased from $336,189 in 1912 to $327,187 in 1913. The output of sand and gravel also decreased from 887,823 short tons in 1912 to 832,909 tons in 1913, with a much larger relative loss in value from $257,597 to $149,286.

Although Nebraska ranks first, and almost alone, in the production of pumice, the output may not be published separately as there are less than three producers in the State. A small quantity of sand-lime brick is manufactured annually in Dodge County. The quantity of mineral waters sold is also unimportant. Statistics of the mineral production of Nebraska in 1912 and 1913, distributed by substances, are shown in the following table:

Mineral production of Nebraska in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products	.....	.....	.....	$805,398	.....	.....	.....	[a] $886,166
Mineral waters.....gallons sold	(b)	(b)	.....	.....	105,985	$10,599	.....	.....
Pumice.....short tons	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Sand and gravel.....do	887,823	$257,597	.....	.....	832,909	149,286	.....	.....
Sand-lime brick	.....	.....	.....	(b)	.....	.....	.....	(b)
Stone	.....	(c)	.....	[c] 336,189	.....	(c)	.....	[c] 327,187
Miscellaneous	.....	(c)	.....	[c] 91,598	.....	(c)	.....	[c] 60,480
Total value, eliminating duplications	$1,490,582				$1,433,718			

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Raw product included in derived product.

NEVADA.

Nevada is essentially a metal-producing State, metallic products constituting more than 98 per cent of the total value of the State's mineral production. Though Nevada is of much less relative importance at the present time as a mining State than it was in the "glory" days of the famous Comstock lode, it continues to rank first in the production of silver, though that metal is third among the mineral products of the State. The most important mineral product of Nevada is copper, in the production of which Nevada ranks fifth among the States. Gold mining ranks second among the State's mineral industries, value of output considered; and in the production of this metal Nevada ranks fourth among the States, with California, Colorado, and the District of Alaska, first, second, and third, respectively. The production of copper increased about 5 per cent in quantity (from 86,477,494 pounds in 1912 to 90,693,751 pounds in 1913), but with a decline of value from $14,268,787 to $14,057,531. Copper mining is one of the new industries of the State. It did not begin on an important scale until 1908 with the development of the Ely district in White Pine County. The only other producer of importance is Lyon County. In 1907, prior to the development of the Ely district, the copper production of the State was less than 2,000,000 pounds, and in 1913 it exceeded 90,000,000 pounds.

In sympathy with the general tendency in the production of gold the output of Nevada decreased from 650,943 fine ounces, valued at $13,456,180, in 1912 to 570,589 fine ounces, valued at $11,795,130, in 1913. More than 60 per cent of the gold production of Nevada in 1912 and 1913 came from the Goldfield district in Esmeralda County, which began production in 1903, and the Tonopah district in Nye County, which was first productive in 1902. All but about 7 per cent of the gold produced in Nevada is from dry or siliceous ore.

The production of silver did not fall off in sympathy with the decrease in the production of gold, but, on the contrary, increased from 14,369,063 fine ounces, valued at $8,836,974, in 1912 to 16,090,083 fine ounces, valued at $9,718,410, in 1913. By far the larger part of the silver output is from the Tonopah district in Nye County, which contributes about 70 per cent of the total output, mainly from dry or siliceous ores. Churchill County ranks second in importance, Storey County, the home of the Comstock, third, and Lincoln County fourth. To what an extent the Comstock lode has fallen from its high estate in the production of silver is indicated by the fact that in 1876, when this famous district was at its zenith, the output was over 17,000,000 ounces of silver, and in 1913 the total production from Churchill County was only 1,383,257 ounces. Mining on the Comstock began in 1860, ran a spectacular course for 20 years, and then somewhat rapidly declined.

The only other products of significance are zinc and lead. The former showed an increase in quantity and a decrease in value in 1913 as compared with 1912, and the production of lead decreased in both quantity and value. Less important mineral products of the State are clay products, coal (lignite), gem materials, graphite (amorphous), gypsum, infusorial earth, iron ore, lime, mineral

waters, quicksilver, salt, sand and gravel, stone, sulphur, and tungsten ore (concentrates).

The total value of the mineral products of Nevada in 1913 amounted to $37,842,084 against $39,111,828 in 1912, as is shown, distributed according to substances, in the following table:

Mineral production of Nevada in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				(a)				(a)
Coal.....short tons	(a)	(a)			(a)	(a)		
Copper.....pounds			86,477,494	14,268,787			90,693,751	14,057,531
Gems and precious stones				15,356				13,405
Gold.....fine ounces (troy)			650,943	13,456,180			570,589	11,795,130
Graphite, amorphous, short tons	(a)	(a)			(a)	(a)		
Gypsum.....short tons	122,408			468,930	(a)			(a)
Infusorial earth				(a)				(a)
Iron ore.....long tons	(a)	(a)			(a)	(a)		
Lead.....short tons			9,750	877,505			8,172	719,137
Lime.....do							(a)	(a)
Mineral waters..gallons sold	(a)	(a)			4,897	1,584		
Quicksilver.....flasks			(a)	(a)			1,645	66,178
Salt.....barrels			12,536	15,752			8,971	7,947
Sand and gravel..short tons	(a)	(a)			14,905	3,729		
Silver....fine ounces (troy)			14,369,063	8,836,974			16,090,083	9,718,410
Stone		(b)		(a)				
Sulphur.....long tons	(a)	(a)						
Tungsten ore (60 per cent concentrates)..short tons			(a)	(a)			(a)	(a)
Zinc.....do			6,661	919,286			7,210	807,502
Miscellaneous		118,502		134,556		158,568		492,963
Total value, eliminating duplications	$39,111,828				$37,842,084			

a Value included under "Miscellaneous." b Stone sold rough included in derived product.

NEW HAMPSHIRE.

New Hampshire, like the other New England States, depends chiefly upon its stone quarries for its inclusion in the list of mineral producers. In 1913, when the total value of the mineral products was $2,218,925, quarries contributed two-thirds, or $1,482,771. In 1912, when the total value of the mineral products was $1,949,876, the quarries furnished products valued at $1,311,488. The only stone quarried on a commercial scale is granite, and the principal quarries in operation are in Hillsboro, Merrimack, Cheshire, and Carroll counties, in the order named. The granite is used chiefly for building and monumental purposes.

Next to granite, and with a product valued at about one-third of it, is the manufacture of common brick, which, with a small output of pottery, represents the only use made of the clay resources of the State. The value of the brick made in 1913 was $462,534, against $492,096 in 1912. The principal brick-making establishments are located in Strafford and Rockingham counties.

Less important mineral products of the State are fluorspar, garnet (abrasive), occasional gems, mica, mineral waters, sand and gravel, scythestones, and a small quantity of zinc. The value of all the

mineral products in 1913 was $2,218,925 against $1,949,876 in 1912, distributed by substances as shown in the following table:

Mineral production of New Hampshire in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products	.....	.....	.....	[a] $492,096	.....	.....	.....	[a] $462,734
Fluorspar.....short tons	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Garnet.....do	(b)	(b)	.....	.....	(b)	(b)	.....	.....
Gems and precious stones	.....	.....	.....	6 0	.....	.....	.....	665
Mica	.....	.....	.....	37,338	.....	.....	.....	79,671
Mineral waters.....gallons sold	240,568	$10,000	.....	.....	402,3 7	$12,707	.....	.....
Sand and gravel.....short tons	.....	.....	.....	.....	252,000	87,500	.....	.....
Scythestones	.....	.....	.....	(b)	.....	.....	.....	(b)
Stone	.....	(c)	.....	[c]1,311,488	.....	(c)	.....	[c]1,482,771
Zinc.....short tons	.....	.....	.....	.....	.....	.....	1	1,680
Miscellaneous	.....	20,235	.....	78,069	.....	4,927	.....	86,470
Total value, eliminating duplications	$1,949,876				$2,218,925			

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Stone sold rough included in derived product.

NEW JERSEY.

New Jersey is the only State of any importance as a mineral producer in which the utilization of its clay resources constitutes the chief industry and represents over 50 per cent of the total value of the minerals produced. The total value of the clay products of the State in 1913 was $19,705,378 out of a total value for all mineral products of $37,271,129. The clay products of New Jersey, moreover, include every variety of brick and tile and every variety of pottery produced in the United States as classified by the Geological Survey. Of the total value of the clay products in 1913 $10,866,833 was the value of brick and tile and $8,838,545 the value of the pottery. In 1912 the total clay products were valued at $19,838,553, of which $10,902,633 was represented by the output of the brick and tile establishments, and $8,935,920 by the output of the potteries. Although the clay products constitute more than one-half of all the mineral products of the State, New Jersey falls behind both Ohio and Pennsylvania in the value of its clay products; it is second in the value of the pottery products, Ohio ranking first, and fourth in the value of its brick and tile. In both 1912 and 1913 New Jersey was first in the production of china and sanitary ware, and ranks among the first five States in the production of most of the varieties of clay products. Mercer County, in which the city of Trenton is located, is the most important clay-working county, and Trenton is the center of the pottery industry. The principal product of Mercer County is sanitary ware. Middlesex County, second in importance, is the principal producer of common brick, architectural terra cotta, fireproofing tile (other than drain tile), and fire brick. Bergen County is third in the manufacture of common brick. Clay for the manufacture of ordinary brick is dug in twenty out of the twenty-one counties of the

State. Fire clay is produced in Burlington, Camden, Gloucester, Mercer, and Middlesex counties, and saggar clay is produced in Mercer and Ocean counties. Pottery clays are produced in Camden, Essex, Monmouth, Morris, and Union counties, and ball and slip clays are dug at Woodbridge, Sayreville, and South Amboy, in Middlesex County.

Based upon the recoverable metallic content of the ore mined New Jersey is one of the important producers of zinc, and zinc-ore mining is second in importance among the State's mineral industries. In the quantity of zinc contained in the ores mined New Jersey ranks next to Missouri as a zinc producer, and second among all the States. The value of the metallic content of the zinc ore mined in New Jersey was nearly one-half that of the value of the clay products in 1913, and almost exactly 25 per cent of the total mineral value of the State. The recoverable content of the zinc ores mined increased from 69,755 short tons in 1912 to 84,122 tons in 1913, but on account of the decline in the prices of spelter the estimated value of this product declined from $9,626,191 to $9,421,664. The center of the zinc mining industry in New Jersey is the famous Franklin Furnace district in Sussex County, the most northerly county of the State. Mining has been carried on continuously in this district for over 60 years.

Third in importance among the mineral industries of New Jersey is the manufacture of Portland cement, the plants in the vicinity of Phillipsburg, Warren County, being the eastern end of the celebrated Lehigh district of Pennsylvania. The production decreased from 4,490,645 barrels in 1912 to 4,255,015 barrels in 1913, but the value increased from $3,052,098 to $3,638,755.

The principal quarry product of New Jersey is trap rock, produced in the Palisades region (principally Somerset, Passaic, Hunterdon, Essex, and Hudson counties) and used chiefly for road making and concrete. The total value of all stone quarried in New Jersey in 1913 was $1,772,832, of which $1,359,931, or nearly 80 per cent, was the value of the trap rock produced. In 1912 the total value of the stone quarried in New Jersey was $1,716,829, of which the trap rock quarries contributed $1,202,397. Limestone, outside of that used in the manufacture of cement, is used chiefly as crushed stone for concrete and macadam, or for blast furnace flux. It is quarried chiefly in Sussex County, with smaller quarries in Hunterdon and Warren counties. The value of the limestone produced in New Jersey increased from $205,334 in 1912 to $280,680 in 1913. Granite and sandstone are also produced in comparatively small quantities, the former in Warren, Passaic, and Sussex counties, and the latter principally in Bergen and Mercer counties.

New Jersey is one of the four leading States in the production of molding sand. The production in 1913 amounted to 503,648 short tons, valued at $285,677, against 459,397 tons, valued at $279,948, in 1912. The production of building sand increased from 1,425,861 short tons, valued at $316,435, in 1912 to 1,666,057 tons, valued at $369,973, in 1913. The total quantity of sand and gravel produced in 1913 was 3,896,421 short tons, valued at $1,162,050, compared with 3,245,767 tons, valued at $1,146,640, in 1912. Building and molding sands are dug in many counties, particularly along the eastern borders. Fire sand for the manufacture of fire brick is produced in Middlesex County, and filter sand is dug extensively in Burlington

and Cape May counties. Glass sand is dug in Camden, Cumberland, Gloucester, and Middlesex counties.

The production of iron ore in New Jersey decreased from 366,823 long tons, valued at $1,192,816, in 1912 to 291,653 tons, valued at $980,303, in 1913. Other commercial products of the State are occasional gems, lime, manganiferous zinc residuum, mineral paints, mineral waters, sand-lime brick, slate, and talc. There was little difference in the total value of the mineral products of New Jersey in 1912 and 1913, the figures being 37,195,940 and 37,271,129, respectively. The distribution of the production by substances during the last two years is shown in the following table:

Mineral production of New Jersey in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel, short tons			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Cement.....barrels			4,490,645	$3,052,098			4,255,015	$3,638,755
Clay products, short tons	438,883	b $702,008		19,838,553	448,135	b $769,689		19,705,378
Coke.....short tons			(a) (b)	(a) (b)			255,792	b 695,041
Gems and precious stones				228				
Iron ore...long tons	366,823	1,192,816			291,653	980,303		
Iron, pig.....do			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Lime.....short tons			16,538	65,241			14,378	55,775
Manganiferous zinc residuum, long tons	104,670	314,010			102,239	306,717		
Mineral paints, natural pigments, short tons			(a)	(a)			(a)	(a)
Mineral waters, gallons sold	2,386,217	209,726			2,067,277	188,546		
Sand and gravel, short tons	3,245,767	1,146,649			3,896,421	1,162,050		
Sand-lime brick				6,924				15,757
Slate				(a)				(a)
Stone		(c)		c1,716,829		(c)		c1,772,832
Talc.....short tons	(c)	(c)	(a)	(a)	(c)	(c)	(a)	(a)
Zinc.....do			69,755	9,626,191			84,122	9,421,664
Miscellaneous				1,302,425				1,616,355
Total value, eliminating duplications			$37,195,940				$37,271,129	

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

NEW MEXICO.

Until 1912 New Mexico, unlike most of the other States of the Rocky Mountain section, owed its importance as a mining State chiefly to its output of coal, and did not figure prominently as a metal-producing State. In 1912, however, owing to a marked increase in the production of copper, that metal became of more importance than coal, and in 1913 showed a further increase of over $3,000,000 in the value of its production. The recoverable content of the copper ore mined in New Mexico in 1913 was almost 50 per

cent of the total value of the mineral production of the State in that year. This increase in the production of copper has been due principally to the operations of one company mining with steam shovels on a large deposit of low-grade ore at Santa Rita, in Grant County. In 1911 the recoverable content of the ores mined in New Mexico was only 4,057,040 pounds, valued at $507,130. In 1912 it rose to 34,030,964 pounds, valued at $5,615,109, the quantity of output being approximately eight and a half times that of the previous year, while the value was more than eleven times. In 1913 the production further increased to 56,308,706 pounds, valued at $8,727,850.

The production of coal increased from 3,536,824 short tons, valued at $5,037,051 in 1912, to 3,708,806 tons, valued at $5,401,260, in 1913. With the interruptions to coal-mining operations in Colorado, due to labor troubles, the production of coal in New Mexico should have shown a considerably larger increase than that actually made; but the explosion in one of the mines of the Stag Canyon Fuel Co., at Dawson, cost the lives of 261 men and naturally interrupted mining operations for a considerable length of time. The disaster at Dawson was the worst that occurred in the coal mines in the United States during the year. The principal coal-mining operations are in the Raton district of Colfax County and in the Gallup district of McKinley County. These two districts produced more than 90 per cent of the total of the State. The Raton district produces a good quality of coke, and extensive coking operations are carried on at Dawson, Gardiner, and Koehler. Near the end of 1913 arrangements were made whereby coal from the Cerillos-Madrid field in Santa Fe County is to be used for generating power in the development of placer and lode mines in the San Pedro district.

The combined value of the gold, lead, silver, and zinc production of New Mexico in 1913 was $2,966,152, or 34 per cent of the value of the copper. The gold production, most of which is from siliceous ores mined at Mogollon, in Socorro County, was valued at $881,926, against $784,446 in 1912. The Mogollon district is also the chief producer of silver, which increased from 1,536,701 fine ounces, valued at $945,071, in 1912 to 1,631,273 fine ounces, valued at $985,289, in 1913. The recoverable zinc content of ores produced in New Mexico increased from 6,783 short tons in 1912 to 8,262 short tons, but the value decreased from $936,098 in 1912 to $925,297 in 1913. The zinc-producing counties are Socorro, Grant, Luna, and Santa Fe, all of the product of Santa Fe County and part of that of Socorro County being from lead-zinc ores. The lead production is relatively unimportant, having amounted in 1913 to 1,973 short tons, valued at $173,640, against 2,747 short tons, valued at $247,231, in 1912.

The only stone quarried to any extent in the State is limestone, quarries being located in Valencia, Guadalupe, and Lincoln counties. It is used chiefly for railroad ballast. The value of the stone products showed a decrease from $335,937 in 1912 to $219,566 in 1913.

The clay-working industries have not been extensively developed, the total value of the clay products being $176,528, against $185,575 in 1912, a slight decrease. The principal clay product is common brick. Fire clay is mined in McKinley and Socorro counties, and some fire brick is made in the State and used principally in the building of coke ovens. The other commercial mineral products of

the State are fluorspar, occasional gems, gypsum, iron ore, lime, mica, mineral waters, petroleum, salt, sand and gravel, and tungsten ore. During 1913 a deep prospecting well penetrated at about 1,600 feet a large body of rock salt. Graphite and asbestos deposits have been located in the Sandia Mountains but have not yet been developed. The total value of the mineral products increased (principally on account of the larger copper production) from $14,391,355 in 1912 to $17,862,369 in 1913. The value of the mineral products in New Mexico in 1913 was more than double that of 1911, two years before. The distribution of the production, by substances, during the last two years is shown in the following table:

Mineral production of New Mexico in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products, short tons	1,943	[a] $4,214		$185,575	3,513	[a] $9,906		$176,528
Coal, short tons	3,536,824	5,037,051			3,708,806	5,401,260		
Coke, do			413,906	[a] 1,356,946			467,945	[a] 1,548,536
Copper, pounds			34,030,964	5,615,109			56,308,706	8,727,850
Fluorspar, short tons	[b]	[b]			[b]	[b]		
Gems and precious stones				795				3,350
Gold, fine ounces (troy)			37,948	784,446			42,663	881,926
Gypsum, short tons	[b]			[b]	43,180			102,564
Iron ore, long tons	[b]	[b]			164,085	148,405		
Lead, short tons			2,747	247,231			1,973	173,640
Lime, do			1,325	9,434			1,246	8,612
Mica				[b]				[b]
Mineral waters, gallons sold	[b]	[b]			154,800	16,730		
Petroleum, barrels					[b]	[b]		
Salt, do			[b]	[b]			[b]	[b]
Sand and gravel, short tons	125,872	29,963			[b]	[b]		
Silver, fine ounces (troy)			1,536,701	945,071			1,631,273	985,289
Stone		[c]		[c] 335,937		[c]		[c] 219,566
Tungsten ore (60 per cent concentrates), short tons							[b]	[b]
Zinc, short tons			6,783	936,098			8,262	925,297
Miscellaneous		179,428		85,217		62,427		28,925
Total value, eliminating duplications	$14,391,355				$17,862,369			

[a] Value not included in total value. [b] Value included under "Miscellaneous."
[c] Stone sold rough included in derived product.

NEW YORK.

New York, first in the number of its inhabitants and first in the value of its manufactures, ranks fifteenth in the value of its total mineral production; but although ranking relatively low among the States in total value of its mineral output, is second in the number of mineral substances produced, and ranks first, value considered, in the production of six mineral substances, namely, emery, abrasive garnet, graphite, gypsum, millstones, and fibrous talc. It is second

in the production of feldspar, natural cement, infusorial earth, commercial mineral waters, salt, sand and gravel, iron pyrite, and sand-lime brick; third in the production of mineral paints (natural pigments) and stone, and fourth in the production of iron ore and Portland cement. All of these substances, however, in which New York ranks relatively high, with the exception of iron ore, are not of conspicuous importance in the mining industry. The clay-working and quarrying industries furnish the products of chief value. New York lies entirely outside of the coal-bearing formation, and consequently produces no solid mineral fuel, but it has a significant production of both natural gas and petroleum, each of which had an output exceeding $2,000,000 in 1913. Its one primary metal product of commercial importance is iron, but the larger part of the pig iron made in the State is from Lake Superior ores. The output from the blast furnaces amounted in 1913 to 1,967,449 long tons, valued at $30,203,673, against 1,973,090 long tons, valued at $28,059,058, in 1912, whereas the total value of the mineral products of the State was $41,594,052 in 1913 and $38,431,910 in 1912. From this it appears that the value of pig iron in New York is about three-fourths that of the total mineral products, but the basis of iron production is the quantity and value of the ore produced, and the value of the pig iron is not included in the total value of the mineral production. The quantity of iron ore mined in the State was 1,420,889 long tons, valued at $3,100,235, against 1,167,405 tons, valued at $2,933,024, in 1912, these figures indicating that the value of the pig iron was nearly 10 times that of the iron ore. The principal contributor to the total value of the mineral production is the clay-working industry, whose products in 1913, including pottery, were valued at $11,469,476, against $12,058,858 in 1912, the decrease in 1913 being due to a falling off in the output of common brick in the Hudson River region. Common brick is the chief clay product of the State, and is manufactured principally in the Hudson River region embracing the counties of Albany, Columbia, Dutchess, Greene, Orange, Rensselaer, Rockland, Ulster, and Westchester, this being probably the largest brick-producing region in the world. New York contributes to each variety of clay products as classified by the Survey, and next to common brick the chief values are from the manufacture of porcelain electrical supplies and architectural terra cotta. Brick kilns are widely distributed over the State and are found in nearly every county. Tile and terra cotta are made in Albany, Allegany, Erie, Kings, Monroe, New York, Oneida, Queens, Steuben, and Rensselaer counties. Fire clay is dug on Staten Island in Richmond County, and on Long Island in Suffolk County. Pottery clays are dug intermittently in Chemung, Dutchess, Monroe, Oneida, Onondaga, Richmond, and Suffolk counties, and kaolin is mined in Dutchess County. Albany slip clay is mined and shipped from near Albany in Albany County, deriving its name, as might be inferred, from the locality in which it is produced. The clay-working industries contribute about 30 per cent of the total value of the mineral products of the State, being slightly less than that proportion in 1913 and more in 1912.

Second in importance among the mineral products of the State is the output of the quarries, the value of the stone production in 1913 being $7,185,493, as compared with $6,415,015 in 1912; and, as pre-

viously stated, New York ranks third in the total value of quarry products, being exceeded only by Pennsylvania and Vermont. The principal quarry product is limestone and the chief producing counties are Erie, Ulster, Onondaga, Genesee, Rockland, Niagara, and Albany, in the order named; limestone is also quarried in some 25 other counties. Its principal use is for road making and railroad ballast, concrete, and flux, nearly 90 per cent of the total value of the limestone quarried being used for these purposes. Limestone constitutes nearly 50 per cent of the total value of the quarry production. A little over 20 per cent of the total value of the stone production is from sandstone quarries, the operations being located in 20 different counties, chief among which is Orleans. At one time the brown sandstones of New York were highly valued as building material, as testified to by the older residence portions of the city of New York. Modern construction in the metropolis, however, both in residences and business edifices, demands other materials for exterior work, and the use of brown sandstone has largely ceased. Bluestone, a variety of sandstone, used principally for building, curbing, and flagging, is quarried in Ulster, Delaware, and Wyoming counties. Trap rock, which is third among the quarry products, is produced chiefly in Rockland County and is used principally for concrete and road making. Granite and marble are also produced, the combined value of these in 1913 being approximately $1,000,000, about the same as that of trap rock alone.

Third among the mineral products of the State is cement, the marketed production of which amounted in 1913 to 5,354,129 barrels, valued at $4,918,119, as compared with 4,857,960 barrels, valued at $3,610,365, in 1912. The manufacture of natural cement, which at one time was an important industry actually and relatively in New York, has been almost entirely supplanted by Portland cement, of which a more uniform product can be made than is possible in the manufacture of natural cement. The location of the natural cement industry was in the vicinity of Rosendale, and by far the larger part of the natural cement produced in the United States was from this district, so that natural cement was known for some years under the commercial name of Rosendale. During the last decade of the nineteenth century the average annual production of natural cement was about 8,000,000 barrels. In 1904 the decline began and continued rapidly until at the present time the total production of natural cement in the United States is valued at less than $400,000 a year.

The output of iron ore, which ranks fourth in importance among the State's mineral industries, is principally magnetite, of which large deposits exist in the Adirondack region. The production was from the vicinity of Lake Champlain at Mineville, Port Henry, Lyon Mountain, and Benson. Workable deposits occur at other places. Some hematite was also produced in Oneida and Wayne counties.

The gypsum products of the State in 1912 were valued at $1,241,514 and in 1913 at $1,280,699. This is one of the six mineral industries in which New York ranks first. The quantity of gypsum mined in 1912 was 506,996 short tons and 529,627 tons in 1913. The values as given above are for the production in the condition when first sold, whether the material was marketed crude, ground for land plaster.

or calcined into various plasters. When calcined, the value of the calcined product is considered. The principal counties in the production of gypsum are Erie, Genesee, Monroe, and Onondaga.

New York ranks second in the production of salt, about half of which is obtained from evaporation of brine, principally in Schuyler, Tompkins, Wyoming, and Onondaga counties. The production in Onondaga County is obtained largely by solar evaporation from brines taken from the State reservation. The production in the other districts, of which Warsaw, in Wyoming County, is the most important, is obtained by artificial evaporation.

The production of fibrous talc is practically a monopoly enjoyed by New York. It is used in the manufacture of medium grades of paper and is produced almost exclusively at Gouverneur, in St. Lawrence County.

Fifth in importance among the mineral products of the State of New York is sand and gravel, the output of which amounted to 8,624,093 short tons, valued at $2,963,663, against 7,237,303 short tons, valued at $2,561,516, in 1912. Building sand constitutes 45 per cent of the total value, and nearly 30 per cent more is in the value of the gravel, which is also largely used for structural work.

The value of the natural gas produced in the State increased from $2,343,379 in 1912 to $2,425,633, and became in 1913 the sixth in importance among the State's mineral products.

The only other natural product whose value exceeded $1,000,000 was petroleum, which was valued at $2,169,357 in 1913.

Coke is made in by-product ovens at Lackawanna, Syracuse, and Geneva from coal mined in Pennsylvania. The production of coke decreased slightly, from 794,618 short tons, valued at $3,203,133, in 1912 to 758,486 short tons, valued at $3,301,400, in 1913. The value of the coke production, however, like that of pig iron, is not included in the total value.

The production of aluminum, obtained by electric smelting at Niagara Falls and Massena, is one of the industries in which New York leads, but the statistics of production in the State may not be published without divulging confidential information. This product is not included in the statement of total value.

In addition to the substances discussed above, New York produces gems (occasionally), lime, mica, metallic paints and other natural pigments, silica (quartz), slate, and zinc. The total value of the mineral products was $41,594,052 in 1913, against $38,431,910 in 1912, distributed by substances, as shown in the following table:

Mineral production of New York in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Abrasives, artificial, pounds			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Aluminum....pounds			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Briquets, fuel, short tons			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Cement.....barrels			4,857,960	$3,610,365			5,354,129	$4,918,119
Clay products, short tons	7,845	b $18,718		12,058,858	5,518	b $9,568		11,469,476
Coke.....short tons			794,618	b3,203,133			758,486	b 3,301,400
Emery.....do	(a)	(a)			957	4,785		
Feldspar.....do	22,192	101,525			22,750	119,060		
Ferro-alloys.long tons			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Garnet, abrasive, short tons	4,366	143,302			4,990	173,695		
Gems and precious stones				100				
Graphite:								
Crystalline, pounds	2,648,000	146,415			(a)	(a)		
Artificial .pounds			12,896,347	b 830,193			13,633,342	b 973,397
Gypsum...short tons	506,996			1,241,514	529,627			1,280,699
Infusorial earth				(a)				(a)
Iron ore.....long tons	1,167,405	2,933,024			1,420,889	3,100,235		
Iron, pig.....do			1,973,090	b28,059,058			1,967,449	b30,203,673
Lime.....short tons			109,800	495,265			114,071	503,157
Mica				(a)				(a)
Millstones				34,246				21,987
Mineral paints, natural pigments.short tons			15,988	72,972			16,002	39,891
Mineral waters, gallons sold	10,008,801	1,034,477			9,801,255	871,601		
Natural gas		2,343,379				2,425,633		
Petroleum.....barrels	874,128	1,401,880			902,211	2,169,357		
Pyrite.....long tons	(a)	(a)			(a)	(a)		
Salt.....barrels	(a)	(a)	6,630,914	1,743,587	(a)	(a)	6,619,857	1,783,062
Sand and gravel, short tons	7,237,303	2,561,516			8,624,093	2,963,663		
Sand-lime brick				128,700				136,013
Silica.....short tons	(a)	(a)			(a)	(a)		
Slate				135,207				144,882
Stone		(c)		c6,415,015		(c)		c 7,185,493
Talc, fibrous, short tons			66,867	656,270			81,705	788,500
Zinc.....short tons			14	1,932				
Miscellaneous		1,169,746		10,605,351		1,489,029		11,771,475
Total value, eliminating duplications		$38,431,910				$41,594,052		

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

NORTH CAROLINA.

North Carolina is not of much importance as a mineral producer, although it leads in the production of mica and has been the principal producer of monazite. None of the latter mineral, however, has been mined in North Carolina, nor in the United States, on a commercial scale for the last three years, the market being supplied by material imported principally from Brazil. The total value of the mineral products in 1913 was $3,739,696, an increase of $370,773, or 11 per cent over 1912, when the value of the minerals produced was $3,368,923. The principal product of value was the manufactures of clay, which in 1913 amounted to $1,614,406, against $1,465,653 in 1912. The chief clay products are common brick and sewer pipe, with smaller quantities of front brick, drain tile, fire brick, and pottery. Common brick is made from local clay pits in 67 counties out of 98 in the State. The principal clay-working counties are Guilford, Wayne, and Wake. Some refractory and siliceous clays for the manufacture of fire brick are dug in Buncombe, Cleveland, and Guilford counties. North Carolina leads all the other States in the production of kaolin, a high-grade white-burning clay used by potters. It is mined in Jackson, Macon, Mitchell, and Swain counties. Other pottery clays are mined in Buncombe, Burke, Chatham, Gaston, Johnston, Lincoln, Moore, Rockingham, Union, and Wilkes counties. The value of the raw clay produced and sold in 1913 was almost exactly the same as in 1912, the figures for the two years being $139,821 in 1912 and $139,644 in 1913. In quantity, however, there was an increase from 15,058 short tons in 1912 to 16,352 tons in 1913, indicating lower prices in the latter year.

Second in importance among the mineral products of North Carolina is stone, the value of the output of which has increased almost constantly during the last 10 years. In 1903 the value of quarry products in North Carolina was only $224,512, whereas in 1913 it was $1,212,501. The principal stone quarried is granite, obtained chiefly in Buncombe, Mecklenburg, Rockingham, Rowan, Surry, Vance, and Warren counties. Granite from the two last-mentioned counties is shipped to many parts of the United States, and to this fact is due the greater part of the increased production during the last few years. The value of the granite quarried in 1913 was $1,116,475, more than 90 per cent of the total stone products. Limestone, marble, and sandstone are quarried in relatively small quantities. The larger part of the production of granite is for curbing and paving blocks; crushed stone for concrete, road making, and railroad ballast coming second; and that used for building purposes, third.

The white muscovite mica produced in North Carolina is highly prized for its transparency and is generally recognized as the standard mica of the country, equal to any in the market. It is especially adapted to the manufacture of gas-lamp chimneys and lamp shades and for the glazing features of heating stoves. Only clear mica of good grade and perfect cleavage is used in the glazing trade. Smaller sizes are used in the manufacture of electrical apparatus, and scrap mica is ground and sold for use in the manufacture of lubricants, for wall paper, etc. The mica produced in North Carolina in 1913 was valued at $267,913, agianst $256,549 in 1912. The production in 1913 consisted of 803,462 pounds of sheet mica, valued at $230,674, and 2,729 tons of scrap mica, valued at $37,239.

North Carolina is the principal gold producer among the Eastern States, the value of the gold produced in North Carolina in 1913 being nearly 80 per cent of the total gold production east of Mississippi River. Compared with the gold-producing States of the Rocky Mountain and Pacific coast sections, however, North Carolina is relatively unimportant, and was less so in 1913 than in 1912, the production of gold in the State decreasing from 8,031 fine ounces, valued at $166,014, in 1912 to 6,117 fine ounces, valued at $126,448, in 1913. In the early history of the United States North Carolina was an important producer of gold, but after the discovery of this metal in California and in Colorado and other Rocky Mountain States, the mining of gold in North Carolina and in any of the Eastern States fell into insignificant proportions. Small quantities of copper, lead, silver, and zinc have also been produced in North Carolina, but the only output of these metals in 1913 was 10 tons of zinc, valued at $1,142, and less than 2,000 ounces of silver.

The iron-ore production of North Carolina is the magnetic ore of the Cranberry iron mine, in Avery County. There is a constantly increasing demand for the pig iron made from this ore, as it is especially adapted to certain uses in which exceptionally pure pig iron is required. The iron resources of Ashe County are now under investigation, and some developments in this region are looked for.

North Carolina is also one of the leading producers of talc, some of which, mined in Moore County, is of exceptional quality. Other mineral substances produced in the State in relatively small quantities are barytes, coal, feldspar, abrasive garnet, gems particularly of the corundum varieties, lime, millstones, mineral waters, sand and gravel, and silica (quartz). The following table shows the quantity and value of the mineral products in North Carolina in 1912 and 1913:

Mineral production of North Carolina in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Clay products.....do....	15,058	b $139,821	.....	$1,465,653	16,352	b $139,644	.....	$1,614,406
Coal.....do....	(a)	(a)	.....	.....	.....	.....	.....	.....
Copper.....pounds..	.....	.....	75,915	12,526	.....	.....	.....	.....
Feldspar.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Garnet, abrasive.....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gems and precious stones....	.....	.....	.....	5,655	.....	.....	.....	849
Gold.....fine ounces (troy)..	.....	.....	8,031	166,014	.....	.....	6,117	126,448
Iron ore.....long tons..	(a)	(c)	.....	.....	(a)	(a)	.....	.....
Lead.....short tons..	.....	.....	46	4,140	.....	.....	.....	.....
Lime.....do....	.....	.....	6,693	30,559	.....	.....	9,815	47,838
Mica.....	.....	.....	.....	256,549	.....	.....	.....	267,913
Millstones.....	.....	.....	.....	9,352	.....	.....	.....	8,772
Mineral waters..gallons sold..	144,708	22,385	.....	.....	176,068	23,877	.....	.....
Sand and gravel..short tons..	161,198	38,487	.....	.....	400,577	127,574	.....	.....
Silica.....do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Silver.....fine ounces (troy)..	.....	.....	4,854	2,985	.....	.....	1,812	1,095
Stone.....	.....	(c)	.....	c1,054,872	.....	(c)	.....	c1,212,501
Talc and soapstone, short tons	(c)	(c)	c3,542	c63,304	412	921	4,264	47,396
Zinc.....do....	.....	.....	142	19,549	.....	.....	10	1,142
Miscellaneous.....	.....	216,893	.....	.....	.....	258,464	.....	.....
Total value, eliminating duplications.....	$3,368,923				$3,739,696			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

NORTH DAKOTA.

North Dakota belongs to the Great Plains region and does not lay claim to any importance as a mineral producer. The total value of the mineral output in both 1912 and 1913 was only a little more than $1,000,000, nearly three-fourths of which was the value of the lignite and the other one-fourth was largely made up by the value of the clay products. The only other mineral substances produced commercially are small quantities of mineral waters, natural gas, sand and gravel, and sand-lime brick, the aggregate value of which amounted to less than $50,000.

The lignite of North Dakota has been found to make excellent fuel for burning brick, as it is relatively free from smoke, maintains a uniform temperature in the kilns, and is much cheaper than any other fuel in the State. As the gas producer and internal-combustion engines in large units come into more general use in the West, as they are rapidly doing in the East, the lignites of North Dakota will be found to possess great potentialities in the settlement and economic development of the State. Experiments conducted under the supervision of the University of North Dakota have furnished convincing evidence that a satisfactory domestic fuel in the form of briquets can be made from the lignite of North Dakota. The only mine operated by the United States Governement is on one of the lignite beds of North Dakota, where the United States Reclamation Service mines its own lignite for use in the irrigation plant at Williston. The output of the Reclamation Service mine is included in the total production of the State. The area underlain by lignite in North Dakota is larger than the total coal area of any other State, with the exception of Illinois and Montana. The production of lignite decreased from 499,480 short tons, valued at $765,105, in 1912 to 495,320 short tons, valued at $750,652, in 1913. The principal producing counties are Burleigh, Stark, and Ward.

The value of the clay products, principally common brick, increased from $231,245 in 1912 to $262,580 in 1913.

The following table shows the quantity and value of the mineral products of North Dakota in 1912 and 1913:

Mineral production of North Dakota in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value	Quantity.	Value.	Quantity.	Value.
Clay products.....short tons..	(a)(b)	(a)(b)	.....	$231,245	(a)(b)	(a)(b)	.....	$262,580
Coal.....do....	499,480	$765,105	.....	.....	495,320	$750,652	.....	.....
Mineral waters.....gallons sold..	.....	.....	.....	.....	582,356	14,403	.....	.....
Natural gas.....	.....	(a)	.....	.....	.....	(a)	.....	.....
Sand and gravel.....short tons..	31,803	16,514	.....	.....	17,226	10,580	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Miscellaneous.....	.....	(c)	.....	c13,831	.....	(c)	.....	c18,060
Total value, eliminating duplications.....	$1,025,741				$1,055,676			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included under derived product.

OHIO.

Ohio ranks fourth among the States in the value of its mineral production. It is the premier State in the value of clay products and in the manufacture of grindstones and pulpstones. It is second in the production of lime, third in the output of bromine, calcium chloride, natural gas, oilstones, salt, sand and gravel, and scythestones, and fourth in the production of coal, gypsum, and stone; and seventh in quantity and sixth in value in the production of petroleum. Ohio ranks next to Pennsylvania and second in the country in the manufacture of pig iron, and if pig iron rather than iron ore were taken as the basis of iron production, Ohio would rank second in the total value of its mineral products, which would be increased in 1913 by more than 90 per cent over the value as obtained when pig iron is excluded. Practically all of the pig iron made in Ohio, however, is from Lake Superior ores and the iron production is credited to the State in which the iron ore was mined. The two leading products of Ohio are coal and manufactures from clay, the former having slightly the better of it in 1912 and 1913, whereas in 1911 the value of the clay products exceeded that of coal. The production of coal in 1913 amounted to 36,200,527 short tons, valued at $39,948,058, the output both in quantity and value being the maximum record for the State. In 1912, when the previous maximum output was obtained, the production amounted to 34,528,727 short tons, valued at $37,083,363, the production in 1913 showing an increase of 1,671,800 tons in quantity and of $2,864,695 in value. All of the coal production of Ohio is of the bituminous variety, though some of it, like the block coal of Indiana, is usable raw for a blast-furnace fuel. When so used it is generally mixed with coke. The principal coal-producing counties are, in the order of their importance, Belmont, Jefferson, Athens, Guernsey, Perry, Hocking, and Tuscarawas. All of the counties east of a line drawn from Cleveland on the north to Portsmouth on the south, with the exception of Ashtabula, Geauga, and Lake counties, are producers of coal. Belmont County, the most important producing county of the State, attained for the first time in its history a production of over 10,000,000 tons in 1913. One other county, Jefferson, produced over 5,000,000 tons, and two others, Athens and Guernsey, each produced over 4,000,000 tons.

The value of the clay products, including pottery, increased about 10 per cent, from $34,811,508 in 1912 to $38,388,296 in 1913. Brick and tile represented about 55 per cent of the total value of the clay products of Ohio and pottery about 45 per cent. In 1913 the output of the brick and tile works was valued at $21,868,407, and the pottery products were valued at $16,519,889. The principal clay-working counties are Columbiana, Muskingum, Summit, Jefferson, Mahoning, Perry, Stark, Cuyahoga, Tuscarawas, and Carroll, in the order named. Sewer pipe represents the largest value in the products of brick and tile industry, with vitrified brick second, tile other than drain third, and common brick fourth. The pottery industry of Ohio is made up largely of the manufacture of high-grade wares, most of the plants being along the Ohio River in the eastern part of the State at East Liverpool and Wellsville, Columbiana County, at Zanesville and other places in Muskingum and Perry counties,

and around Athens in Summit County. Over 60 per cent of the total production of the pottery products in Ohio is white ware, although stone ware, yellow and Rockingham ware, and porcelain electrical supplies constitute important products. Ohio was exceeded in 1913 by Pennsylvania in the value of its brick and tile products by less than $320,000; in the value of pottery Ohio led New Jersey, second in rank in this respect, by more than $7,500,000, or nearly 90 per cent of New Jersey's product.

The production of petroleum, which ranks third among the State's mineral industries and in which Ohio ranks sixth, value considered, among all the States, decreased slightly in quantity, from 8,969,007 barrels in 1912 (including a small output from Michigan) to 8,781,468 barrels in 1913, while the value increased about 45 per cent, from $12,085,998 to $17,538,452. The principal petroleum-producing counties are Allen, Hancock, Lucas, Sandusky, Seneca, Van Wert, and Wood, in the northwestern part of the State, and Belmont, Carroll, Fairfield, Harrison, Hocking, Jefferson, Licking, Monroe, Morgan, Noble, Perry, and Washington, in the eastern and southern parts. The production has been declining in the northwest corner of the State, which constitutes a part of the well-known Lima-Indiana field, where the Lima grade of oil is produced, but has been well maintained in the southeastern district, though there was a slight decrease in production in this district also in 1913. The average value per barrel for Lima oil advanced from 99 cents in 1912 to $1.139 in 1913, and that for the southeastern counties (Pennsylvania grade) advanced from $1.63 in1912 to $2.46 in 1913.

In 1912 the value of the natural gas produced in Ohio was only slightly less than that of the petroleum produced, but in 1913, with a decrease of over $1,470,000 in the value of the natural gas produced and an increase of nearly $5,500,000 in the value of petroleum, the latter took the lead over natural gas in the value of output by over $7,000,000, or practically 70 per cent. The value of the natural gas produced in 1913 was $10,416,699 in 1913, against $11,891,299 in 1912. The chief counties in the production of natural gas are Licking, Knox, Ashland, and Fairfield. The producing areas are well scattered over the northern and eastern counties of the State.

Fifth in importance among Ohio's mineral industries is the quarrying of stone. The principal quarry product is limestone, of which there is a large quantity and great variety in the State. The use of this limestone is chiefly for road making, railroad ballast, the manufacture of concrete, iron flux, and lime burning. The principal producing counties are Ottawa, Franklin, Erie, Lucas, Seneca, and Wood, in the order named. The production of sandstone is between 25 and 30 per cent that of limestone. This is largely from the Berea sandstone, or grit, which also produces the grindstones and pulpstones in the production of which Ohio leads. Sandstone is produced in many counties in the eastern half of the State, but the great quarries from which building stone is obtained are in Lorain and Scioto counties. Cuyahoga County is an important producer of sandstone, but the product is used chiefly for curbing and flagging. The total value of the stone produced in Ohio in 1913 was $6,261,338, of which the limestone quarries contributed $4,945,310 and the sandstone quarries $1,316,028. In 1912 the limestone production was valued at

$4,885,008, and the sandstone $1,312,300, the total quarry output being valued at $6,197,388. The limestone production does not include the limestone burned into lime, of which (lime) there was produced in 1913 497,693 short tons, valued at $1,976,316. In 1912 the lime production amounted to 464,479 short tons, valued at $1,929,584.

Three other products of the State have a value exceeding $1,000,000. These are cement, salt, and sand and gravel. To these might be added also the output of coke, chiefly from retort ovens and from coal mined in West Virginia, which in 1913 amounted to 351,846 short tons, valued at $1,231,554. All kinds of sand have been produced in the State, and in 1913 the total production of sand and gravel amounted to 5,605,767 short tons, valued at $2,092,401, against 5,874,412 short tons, valued at $2,304,968, in 1912. The decrease of over $200,000 in the production of 1913 as compared with 1912 was due principally to a falling off in the production of molding sand, which in 1912 was the chief product of value in the sand and gravel list, and gave way in 1913 to building sand, whose production showed an increase both in quantity and value over 1912. The value of the building and molding sands combined constituted more than 55 per cent of the total value of the sand and gravel produced in the State. The gravel used principally for railroad ballast constituted about 25 per cent of the total sand and gravel production.

The salt production comes from two principal districts, the northeastern, comprising Cuyahoga, Medina, Summit, and Wayne counties, and the southeastern, included entirely in Meigs County. All of the salt is obtained by the evaporation of brine, the grainer process being most generally employed. The production of salt increased from 5,269,179 barrels in 1912 to 5,310,135 barrels in 1913, but the value decreased slightly, from $1,364,136 to $1,318,156.

The other commercial mineral products of Ohio are iron ore, mineral waters, pyrite (a by-product of coal mining), sand-lime brick, and sulphuric acid (from zinc smelting). The total value of the mineral production of Ohio increased from $111,229,656 in 1912 to $121,690,661 in 1913. The distribution by substances is shown in the following table:

Mineral production of Ohio in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bromine..pounds..	.....	.....	106,178	$18,836	.....	.....	(a)	(a)
Calcium chloride, short tons.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Cement....barrels..	.....	.....	1,422,120	1,202,513	.....	.....	1,671,919	$1,757,413
Clay products, short tons.....	356,448	b $262,755	.....	34,811,508	384,325	b $277,455	.....	38,388,296
Coal....short tons..	34,528,727	37,083,363	.....	.....	36,200,527	39,948,058	.....	.....
Coke.....do....	.....	.....	388,669	b 1,365,905	.....	.....	351,846	b 1,231,554
Ferro-alloys, long tons.....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Grindstones and pulp stones.....	.....	.....	.....	787,621	.....	.....	.....	737,572
Gypsum, short tons.....	262,551	.....	.....	812,388	254,863	.....	.....	695,149
Iron ore..long tons..	20,861	40,986	.....	.....	8,299	17,100	.....	.....
Iron, pig.....do....	.....	.....	7,127,176	b93,140,369	.....	.....	6,913,961	b103,824,517
Lime...short tons..	.....	.....	464,479	1,929,584	.....	.....	497,693	1,976,316
Mineral waters, gallons sold.....	2,709,745	117,287	.....	.....	3,317,639	125,084	.....	.....
Natural gas.....	.....	11,891,299	.....	.....	.....	10,416,699	.....	.....
Oilstones and scythestones.....	.....	.....	.....	17,253	.....	.....	.....	(a)
Petroleum..barrels..	c8,969,007	c12,085,998	.....	.....	8,781,468	17,538,452	.....	.....
Pyrite..long tons..	14,487	43,853	.....	.....	13,622	34,998	.....	.....
Salt.....barrels..	.....	.....	5,269,179	1,364,136	.....	.....	5,310,135	1,318,156
Sand and gravel, short tons.....	5,874,412	2,304,968	.....	.....	5,605,767	2,092,401	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Stone.....	.....	(d)	.....	d 6,197,388	.....	(d)	.....	d 6,261,338
Sulphuric acid (60° Baumé) e, short tons.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Miscellaneous.....	.....	.....	.....	901,524	.....	.....	.....	487,129
Total value, eliminating duplications.....	$111,229,656				$121,690,661			

a Value included under "Miscellaneous."
b Value not included in total value.
c Includes production of Michigan, value of which is not included in Ohio State total.
d Stone sold rough included in derived product.
e From zinc smelting.

OKLAHOMA.

Oklahoma has achieved importance as a mining State in the last few years principally on account of its phenomenal increase in the production of petroleum, which followed the discovery of oil in quantity in that State in 1904. The record for 1913 in consequence concludes the first 10 years of petroleum production in quantity in Oklahoma. At the beginning of this period, as a result of considerable drilling in the Osage Indian Reservation and in the vicinity of Bartlesville and Ramona in the Cherokee Nation (then Indian Territory), the production rose to nearly 1,400,000 barrels. This was about 10 times the output of the preceding year (1903). In 1905 the production reached a total of nearly 10,000,000 barrels, and this output was approximately doubled in 1906. In the next two years, or in 1908, it was again more than doubled, with a total production of nearly 46,000,000 barrels. Another 10,000,000 barrel increase was

added in 1911, when the production amounted to 56,069,637 barrels. The first interruption to this steady increase was in 1912, when the output receded to 51,427,071 barrels, but this decrease was more than made up by the production of 1913, when it increased to 63,579,384 barrels. The increase in 1913 over 1912 was 12,152,313 barrels, or 24 per cent, but this increase paled somewhat in comparison with the increase in value, which was from $34,672,604 in 1912 to $59,581,948 in 1913, a difference in favor of the latter year of $24,909,344, or 72 per cent, the percentage of gain in value being three times that in the quantity. Oklahoma now ranks second in quantity among the petroleum-producing States, with California first, but in 1913 the value of the Oklahoma production exceeded that of California by nearly $14,000,000, placing Oklahoma at the head of the list in the value of petroleum output. From 1906 to 1908 Oklahoma stood first also in the quantity of production, but was displaced by California in 1909. Because of the increased value of its petroleum output Oklahoma advanced from twelfth place in 1912 to seventh place among all the States in the total value of its mineral output. The increased production of petroleum in Oklahoma was due to greatly extended drilling, principally within the known oil fields, especially the development to the north and east of the prolific Cushing field. The increased drilling was doubtless somewhat stimulated by the advances in price of Mid-Continent oil.

Oklahoma is also one of the important producers of coal among the Southwestern States, and is the most important producer of natural gas in that section. The coal production increased from 3,675,418 short tons, valued at $7,867,331, in 1912 to 4,165,770 tons, valued at $8,542,748, in 1913. The increase in coal production in 1913 is attributed more to a rather abrupt withdrawal of fuel oil from markets where it had been in competition with Oklahoma coal and to a diminution in the supply of natural gas from the northern part of the Mid-Continent field, particularly in Arkansas. The decreased production of coal in Colorado, due to labor troubles, was also partly responsible for the increased production in Oklahoma. Until 1912 there had not been for 10 years any substantial increase in the production of Oklahoma coal, but in that year there was a gain of about 600,000 tons, followed by another of nearly 500,000 tons in 1913. In the 10 years from 1902 to 1911, inclusive, the production of coal in Oklahoma ranged between 2,646,226 tons in 1910 and 3,642,658 tons in 1907, with an average for the decade of 3,059,984 tons, showing that because of the production and use of fuel oil the output of coal had remained practically stationary. Prior to the admission of Oklahoma as a State the principal production of coal was from the Choctaw Nation, with smaller quantities from Cherokee and Creek nations. Pittsburg County is now the leading producer, with Coal, Okmulgee, and Latimer in the order named. Six other counties also produce coal.

The value of the natural gas produced in 1913 was $7,436,389, as compared with $7,406,528, with an increase in quantity from 73,799,319,000 cubic feet to 75,017,668,000 cubic feet. The total value of the three fuels, coal, petroleum, and natural gas, in 1913 amounted to $75,561,085, or 94 per cent of the total mineral output of the State.

The only other products which had a value in excess of $1,000,000 were cement and zinc, the latter showing an increase from 5,769 short tons, valued at $796,122, in 1912 to 11,664 short tons, valued at $1,306,368, in 1913. As there are only two manufacturers of cement in the State, the totals of production are not published. The zinc ores are entirely from Ottawa County in the northeastern part of the State, which has developed some importance in the production of lead and zinc. The lead content of the ores produced in Oklahoma increased from 3,388 short tons, valued at $304,920, in 1912 to 6,228 tons, valued at $548,064.

The clay products of the State are chiefly common and vitrified brick, the total value of which in 1913 was $573,371, compared with $535,318 in 1912. The principal counties in the utilization of clay resources are Muskogee, Rogers, and Tulsa.

The chief quarry product is limestone, used mainly for railroad ballast and concrete. The quarrying of granite is chiefly for building purposes, and is of some importance in Greer, Johnston, Kiowa, and Sequoyah counties. The total value of the stone produced decreased from $795,879 in 1911 to $429,788 in 1912 and to $278,600 in 1913. The decrease is due to a smaller quantity used for railroad ballast.

The other mineral products of Oklahoma are asphalt, gypsum, lime, commercial mineral waters, salt, sand and gravel, sand-lime brick, and a small quantity of silver. The total value of the mineral products of Oklahoma increased (chiefly because of the increase in petroleum) from $53,614,130 in 1912 to $80,168,820 in 1913. The distribution of the production in 1912 and 1913, by substances, is shown in the following table:

Mineral production of Oklahoma in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	15,766	$85,643	(a)	(a)	16,459	$91,416	9,975	$136,405
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products.....	.....	.....	.....	$535,318	.....	.....	.....	573,371
Coal.....short tons..	3,675,418	7,867,331	.....	.....	4,165,770	8,542,748	.....	.....
Gypsum.....do....	135,074	.....	.....	268,618	147,876	.....	.....	330,416
Lead.....do....	.....	.....	3,388	304,920	.....	.....	6,228	548,964
Lime.....do....	.....	.....	2,651	13,538	.....	.....	2,640	12,160
Mineral waters, gallons sold.....	1,015,512	32,971	.....	.....	502,439	26,231	.....	.....
Natural gas.....	.....	7,406,528	.....	.....	.....	7,436,389	.....	.....
Petroleum.....barrels..	51,427,071	34,672,604	.....	.....	63,579,384	59,581,948	.....	.....
Salt.....do....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Sand and gravel, short tons.....	492,858	163,298	.....	.....	157,628	39,457	.....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Silver, fine ounces (troy).	.....	.....	.....	.....	.....	.....	1,300	785
Stone.....	.....	(b)	.....	b 429,788	.....	(b)	.....	b 278,600
Zinc.....short tons..	.....	.....	5,769	796,122	.....	.....	11,664	1,306,368
Miscellaneous.....	.....	.....	.....	1,037,451	.....	.....	.....	1,264,462
Total value, eliminating duplications.....		$53,614,130				$80,168,820		

a Value included under "Miscellaneous."
b Stone sold rough included in derived product.

OREGON.

Oregon has not risen to much importance as a mining State, its production of only two substances having attained as much as $1,000,000 in any one year, and there is only one which attained that value in 1913. In 1911 the clay-working industries furnished products exceeding $1,000,000 in value, but in both 1912 and 1913 they fell considerably below that amount. In 1913 the gold production was valued at $1,627,710, an increase of more than 100 per cent over that of 1912, when it amounted to $770,041. The clay products, principally of common brick, and exclusive of pottery, were valued at $771,795 in 1913, against $734,226 in 1912. The sand (chiefly building) and gravel increased from 1,067,634 short tons to 1,442,152 tons in 1913, but decreased in value from $499,030 in 1912 to $432,938, and the stone production, principally trap rock (basalt) increased from $268,002 in 1912 to $357,498. Some coal (lignite) has been produced in Coos County for a good many years, but competition with fuel oil from California has taken away its chief market in San Francisco. There was, however, a slight increase in production in 1913 over 1912, from 41,637 short tons, valued at $108,276 in 1912, to 46,063 tons, valued at $116,724.

The other mineral products of the State are copper, occasional gems, gypsum, lead, lime, mineral waters, platinum, and silver. The total value of the mineral products increased (chiefly on account of the larger production of gold) from $2,553,549 in 1912 to $3,563,919 in 1913.

The distribution of the products of the State, by substances, in 1912 and 1913 is shown in the following table:

Mineral production of Oregon in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets.....short tons..	.....	.....	.....	.....	.....	.....	(*a*) (*b*)	(*a*) (*b*)
Clay products.....do....	(*a*) (*b*)	(*a*) (*b*)	.....	*c* $734,226	(*a*) (*b*)	(*a*) (*b*)	.....	*c* $771,795
Coal.....do....	41,637	$108,276	.....	.....	46,063	$116,724	.....	.....
Copper.....pounds..	.....	.....	260,429	42,971	.....	.....	43,330	6,716
Gems and precious stones..	.....	.....	.....	2,000	.....	.....	.....	2,975
Gold, fine ounces (troy)..	.....	.....	37,251	770,041	.....	.....	78,740	1,627,710
Gypsum.....short tons..	.....	.....	.....	.....	(*a*)	.....	.....	(*a*)
Lead.....do....	.....	.....	20	1,768	.....	.....	44	,837
Lime.....do....	.....	.....	6,164	39,323	.....	.....	4,747	80,704
Mineral waters, gallons sold.....	48,351	17,503	.....	.....	68,413	19,409	.....	.....
Platinum, fine ounces (troy).....	.....	.....	39	1,014	.....	.....	16	675
Sand and gravel, short tons.....	1,067,634	499,030	.....	.....	1,442,152	432,938	.....	.....
Silver, fine ounces (troy)..	.....	.....	57,081	35,105	.....	.....	179,036	108,139
Stone.....	.....	(*d*)	.....	*d* 268,002	.....	(*d*)	.....	*d* 357,498
Miscellaneous.....	.....	(*d*)	.....	*d* 34,865	.....	(*d*)	.....	*d* 181,200
Total value, eliminating duplications.....	$2,553,549				$3,563,919			

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of pottery, value for which is included under "Miscellaneous."
d Raw product included in derived product.

PENNSYLVANIA.

Pennsylvania so far exceeds all the rest of the States in the value of its mineral products as to stand almost alone. Exclusive of the value of pig iron, coke, and other derived or secondary products not included in the total, the value of Pennsylvania's mineral production is more than one-fourth that of the entire country, and in 1913 exceeded the combined values of the production of West Virginia, Illinois, Ohio, and California, the next four States in the value of their mineral product, by more than $8,500,000. It was more than three and one-half times the value of West Virginia, which comes second; and more than five times that of California, which ranks fifth. Pennsylvania holds the leadership primarily on account of the State's supremacy in the production of coal. In the combined value of anthracite and bituminous coal Pennsylvania nearly equals the aggregate value in 1913 of all the mineral products of West Virginia, Illinois, and Ohio, second, third, and fourth States, respectively, in rank. It must not be inferred, however, that Pennsylvania depends entirely upon the coal production for its high rank as a mineral-producing State, for, if the value of the entire production of coal in the State were deducted, Pennsylvania would still be as high as fourth in rank, exceeded only by West Virginia, Illinois, and Ohio with their coal production included; and would exceed by more than 15 per cent the value of California's production.

Pennsylvania derives its mineral wealth almost entirely from non-metalliferous mining operations. Except for a small amount of copper, it produces none of the precious or semiprecious metals, and the only other metal which figures in the total production of the State is iron ore, of which a small quantity (less than 500,000 tons in 1913) is mined. In addition, however, to being the premier State in the production of coal, Pennsylvania leads also in the manufacture of cement, the burning of lime, in the production of mineral paints, sand and gravel, slate, and stone. It is second in the value of clay products and natural gas, and has been the leading State in the production of petroleum, but is now exceeded in that particular by four States: Oklahoma, California, Illinois, and West Virginia. Although its production of iron ore is insignificant, Pennsylvania is by far the leading producer of pig iron, which is obtained from Lake Superior ores. The production of pig iron in Pennsylvania in 1913 was 12,871,349 long tons, valued at $197,726,314. If the value of the pig iron made in Pennsylvania were added to the value of the other products of the State, the total value for 1913 would have exceeded $700,000,000, about one-third of the total mineral production in the United States. Even with the value of the pig iron excluded Pennsylvania's contribution to the mineral wealth of the United States in 1913 exceeded the total value of all the mineral products of the United States in any year previous to 1887.

The production of coal in Pennsylvania in 1912 amounted to 246,227,086 short tons, valued at $346,993,123, of which 84,361,598 tons, valued at $177,622,626, was anthracite, and 161,865,488 tons, valued at $169,370,497, was bituminous. In 1913 the production of anthracite coal increased to 91,524,922 short tons, valued at $195,181,127, and that of bituminous to 173,781,217 short tons, valued at $193,039,806. It will be noted that in both years the

production of bituminous coal was nearly double that of anthracite, and that the value of anthracite coal continues to exceed that of bituminous. The combined value of the anthracite and bituminous coal produced in Pennsylvania in 1913 was $388,220,933, an increase of $41,227,810, or 12 per cent over that of 1912. The value of the coal produced in Pennsylvania in 1913 was about 50 per cent of the value of all the coal produced in the United States in that year, about 80 per cent of the total value of Pennsylvania's mineral products, and about one-sixth in value of all the mineral production of the United States.

As is well known, the entire production of anthracite coal is from a limited area, less than 500 square miles in extent, in the eastern part of the State. Nearly one-half of the production of coal in Pennsylvania has been from this small area, and three counties produce over 80 per cent of the total anthracite output—Luzerne, with a production in 1913 considerably in excess of 30,000,000 tons; Lackawanna, whose output was over 20,000,000 tons; and Schuylkill, whose output was between 17,000,000 and 18,000,000 tons. Northumberland produced over 6,000,000 tons; Carbon about 3,000,000 tons; and approximately 3,000,000 tons were obtained in the combined product of Columbia, Dauphin, Sullivan, Susquehanna, and Wayne. The bituminous coal fields extend over the greater part of the western half of the State, and have a total area of more than 14,000 square miles. The principal producing counties are Fayette and Westmoreland, in which is contained the celebrated Connellsville coking district, these two counties having a combined production in 1913 of nearly 66,000,000 short tons. Allegheny County, the home of Greater Pittsburgh and celebrated for its steam coal, is third in importance as a coal producer, producing in 1913, 20,127,823 tons; Cambria, with its iron and steel industries at Johnstown as a large consumer, produced 19,621,378 tons; and Washington, which may be considered a part of the Allegheny district, produced 18,309,317 tons. Two other counties, Somerset and Indiana, have a production of about 10,000,000 tons each; Clearfield over 8,000,000 tons; Jefferson nearly 6,000,000 tons; Armstrong over 5,000,000 tons. Four other counties, Butler, Center, Clarion, and Elk, each produced over 1,000,000 tons.

Second in importance among Pennsylvania's mineral industries is the manufacture of Portland cement, closely followed by the clay-working industry. The Lehigh cement district of eastern Pennsylvania, with a few plants in New Jersey, is the most important cement-making region in the world. Pennsylvania's principal producing center is in the vicinity of Allentown. The Lehigh district, which includes the counties of Northampton, Carbon, Lehigh, and Berks in Pennsylvania, and Warren County in New Jersey, makes nearly one-third of the cement production of the United States. The manufacture of Portland cement in Pennsylvania, however, is not confined to the Lehigh district, but there are other plants located at York, Pittsburgh, Wampum, and Newcastle. The total production of Portland cement in Pennsylvania in 1913 was 28,060,495 barrels, valued at $24,268,800, against 27,539,076 barrels, valued at $18,918,165, in 1912.

Pennsylvania ranks second among the States in the total value of its clay products, and until 1913 the clay-working industry was second in importance among the producers of mineral wealth. The value of the clay products, exclusive of raw clay mined and sold,

increased from $21,537,221 in 1912 to $24,231,482 in 1913. Although ranking second in the total value of its clay products, Pennsylvania is first in the production of brick and tile. In the manufacture of high-grade wares, particularly in pottery, it falls behind Ohio, New Jersey, West Virginia, and New York. Expressed in value, the output of fire brick is the most important of the clay products of Pennsylvania, the State's production being more than one-third of the entire production of fire brick in the United States, and about one-third of the value of all the brick and tile products of the State. The value of the fire brick produced in Pennsylvania was $7,094,794 in 1913, against $6,178,870 in 1912. A large part of the fire clay is mined in connection with coal mining and becomes in reality a by-product of the latter industry. In Allegheny, Armstrong, Beaver, Cambria, Carbon, Clarion, Center, Clearfield, Clinton, Cumberland, Elk, Fayette, Indiana, Jefferson, Lackawanna, Lawrence, Luzerne, Lycoming, McKean, Somerset, and Westmoreland counties fire clay is associated with coal; in Berks, Juniata, Lehigh, Montgomery, Perry, Snyder, and Union counties a clay not associated with the coal measures is mined. Common brick is second among the clay products of the State, and was valued at $4,772,229 in 1913, against $4,590,784 in 1912. The value of front brick increased from $2,321,479 in 1912 to $2,325,201 in 1913. All classes of brick, tile, and terra cotta are made in Pennsylvania, and the total value of these products was $19,408,681 in 1912 and $22,185,383 in 1913. Philadelphia County, with the city of Philadelphia as its principal market, is the third largest common-brick producing center of the country, and Allegheny County is the fourth. Lawrence and Clearfield counties are the principal producers of vitrified brick, and front brick is made principally in Armstrong County.

Fourth in importance among Pennsylvania's mineral products is natural gas, and until 1910 Pennsylvania was the leading State in the production of natural gas. In 1910 West Virginia attained, and has continued to hold, first place in the production of this fuel, but Pennsylvania continues to rank first in its consumption, making up for the shortage in its own production by drawing from the West Virginia wells. The value of the natural gas produced in Pennsylvania increased from $18,539,672 in 1912 to $21,695,845 in 1913.

Up to 1894 Pennsylvania was the leading State in the production of petroleum, but in 1895 it was exceeded by Ohio, the production of Pennsylvania having begun to decline in 1891, while Ohio was approaching its maximum, which was attained in 1896. In more recent years West Virginia, Texas, California, Illinois, Louisiana, and Oklahoma have all risen rapidly in the production of petroleum, and each in quantity of production now exceeds Pennsylvania. On account of the higher grade of Pennsylvania's oil, however, it ranks fifth in the value of this production. The output of petroleum in Pennsylvania increased slightly in quantity from 7,837,948 barrels in 1912 to 7,963,282 barrels in 1913, with an increase of over 50 per cent in value, from $12,886,752 to $19,805,452.

The production of limestone is the principal factor in placing Pennsylvania first as a producer of stone, though the State is also first in the production of slate, sand and gravel, and of lime. In 1913 the total value of the stone quarried in Pennsylvania, exclusive of slate and limestone made into lime, was $10,117,469, against $9,144,214 in

1912. Of this total in 1913 a little over 60 per cent, or $6,189,145, was represented by the production of limestone. The principal use of limestone is for fluxing purposes in the furnaces around Pittsburgh and Johnstown and in the eastern and central parts of the State, 70 per cent of the total limestone quarried being used for this purpose. Limestone valued at $1,000,000 is crushed annually for use in road making, railroad ballast, and concrete. Next in importance to limestone is sandstone, which, including bluestone, was valued at $1,367,601 in 1912, against $1,359,533 in 1913. Trap rock, used chiefly for road making, railroad ballast, and concrete, and granite, used principally for building purposes, are quarried to the extent of something over $1,000,000 each. A small quantity of marble is also produced in Chester, Montgomery, and Northampton counties. The leading counties in the production of limestone are Blair, Butler, Lawrence, and Lebanon, but the stone is quarried in many parts of the State; in sandstone, the principal producing counties are Allegheny, Dauphin, Huntingdon, Lawrence, Luzerne, Pike, Susquehanna, and Wyoming; in trap rock, Berks, Bucks, Delaware, Montgomery, and Northumberland; and in granite, Chester, Delaware, Montgomery, and Philadelphia. The principal slate-making district is in Northampton and Lehigh counties, and Pennsylvania is credited with nearly 60 per cent of the total output of slate in the United States. In 1913 the total production of slate in the United States was $6,175,476, of which Pennsylvania produced $3,733,581. In 1912 the value of Pennsylvania's production was $3,474,247. In addition to Northampton and Lehigh counties, slate is also produced in considerable quantities in York County, which yields the famous Peach Bottom slate; and smaller quantities are produced in Carbon and Lancaster counties.

Pennsylvania has nearly one-half of the total number of lime producers in the United States, but its production is about 25 per cent of the total quantity and only 20 per cent of the total value. Lime burning as an industry is scattered over the State. In 1912 the production amounted to 849,159 short tons, valued at $2,679,420, and increased in 1913 to 852,927 tons, valued at $2,743,197. As an indication of the scattered character of the lime-burning industry, it may be stated that the average value of lime per establishment in Pennsylvania in 1913 was about $5,500.

The combined production of sand and gravel in Pennsylvania in 1913 was 6,702,449 tons, valued at $3,381,692, against 6,509,333 tons, valued at $3,371,513, in 1912. Building sand is the most important of this character of product in the State, but of more relative importance is the production of glass sand, in which Pennsylvania ranks first among the States. It takes second place in the production of molding sand. In the total value of sand produced (although not in the total quantity) Pennsylvania ranks first, the precedence in value being due to the high value of the glass sand as compared to others.

Among the other products which contribute to Pennsylvania's total are bromine, calcium chloride, feldspar, occasional gems, graphite, mica, millstones, mineral waters, pyrite, silica (quartz) salt, sand-lime brick, sulphuric acid, talc, and tripoli. The total value of the mineral products of the State increased from $445,799,653 in 1912 to $506,466,759 in 1913. The distribution of the products by substances is shown in the following table:

Mineral production of Pennsylvania in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Abrasives, artificial.....pounds..			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Briquets.....short tons..			55,491	b $143,720			29,917	b $79,179
Bromine.....pounds..			(a)	(a)			(a)	(a)
Calcium chloride.....short tons..			(a)	(a)			(a)	(a)
Cement.....barrels..			27,625,340	18,945,835			c 28,060,495	c 24,268,800
Clay products.....short tons..	462,605	b $741,484		21,537,221	479,548	b $836,916		24,231,482
Coal:								
Anthracite.....do....	84,361,598	177,622,626			91,524,922	195,181,127		
Bituminous.....do....	161,865,488	169,370,497			173,781,217	193,039,806		
Coke.....do....			27,438,693	b 56,336,255			28,753,444	b 67,929,864
Copper.....pounds..			(a)	(a)			503,792	78,088
Feldspar.....short tons..	9,451	71,287			9,629	75,851		
Ferro-alloys.....long tons..			203,844	b 9,523,815			212,719	b 10,939,453
Gems and precious stones				103				1
Graphite, crystalline.....pounds..	(a)	(a)			393,817	19,242		
Iron ore.....long tons..	522,172	481,353			478,693	589,038		
Iron, pig.....do....			12,437,685	b 181,569,299			12,871,349	b 197,726,314
Lime.....short tons..			849,159	2,679,420			852,927	2,743,197
Mica								(a)
Millstones				(a)				(a)
Mineral paints:								
Natural pigments.....short tons..			33,326	284,082			38,304	303,257
Zinc-lead pigments.....do....			(a)	(a)			(a)	(a)
Mineral waters.....gallons sold..	2,192,106	204,906			2,163,931	190,459		
Natural gas		18,539,672				21,695,845		
Petroleum.....barrels..	7,837,948	12,886,752			7,963,282	19,805,452		
Pyrite.....long tons..	(a)	(a)						
Salt.....barrels..			(a)	(a)			(a)	(a)
Sand and gravel.....short tons..	6,509,333	3,371,513			6,702,449	3,381,692		
Sand-lime brick				36,970				73,674
Silica.....short tons..	(a)	(a)			(a)	(a)		
Slate				3,474,247				3,733,581
Stone		(d)		d 9,144,214		(d)		d 10,117,469
Sulphuric acid (60° Baumé) e.....short tons..			(a)	(a)			(a)	(a)
Talc.....do....	(d)	(d)	(a)	(a)			(a)	(a)
Tripoli								(a)
Miscellaneous		36,855		7,161,100		(d)		d 6,995,398
Total value, eliminating duplications		$445,799,653				$506,466,759		

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of natural cement and Puzzolan, value for which is included under "Miscellaneous."
d Raw product included in derived product.
e From zinc smelting.

RHODE ISLAND.

The only mineral products which Rhode Island has contributed commercially during the last few years are stone, mineral waters, lime, amorphous graphite, soapstone, coal, and the manufactures of clay. The total value of the mineral products in 1913 was $813,952, of which the quarries contributed $643,995. In 1912 the total value was $942,842, of which the quarries contributed $768,067.

The following table gives the quantity and value of the mineral production of Rhode Island for 1912 and 1913:

Mineral production of Rhode Island in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets.....short tons.	.....	.....	(a)	(a) (b)	.....	.....	.....	.....
Clay products.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Coal.....short tons.	(a)	(a)	.....	.....	.....	.....	.....	.....
Graphite, amorphous...do....	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Lime.....do.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters...gallons sold.	456,803	$29,126	.....	.....	444,036	$28,533	.....	.....
Soapstone.....short tons.	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Stone.....	.....	(c)	.....	$768,067	.....	(c)	.....	$643,995
Miscellaneous.....	.....	43,443	.....	118,329	.....	8,841	.....	132,581
Total value, eliminating duplications.....		$942,842				$813,952		

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough not included in derived product.

SOUTH CAROLINA.

Up to the close of 1911 the most important mining industry in South Carolina was that of phosphate rock. In 1912, owing to a decrease in the production of this material and an increase in the value of the clay products, the phosphate-mining industry gave way to clay working as first in rank. The production of phosphate rock continued to decrease in 1913, and although there was also a decrease in the value of the clay products, the latter still maintains first place. The phosphate-mining industry of South Carolina does not have the same actual or relative importance at the present time that it had in the later years of the last century. Until the discovery of the workable phosphate beds in Florida in 1888, South Carolina enjoyed practically a monopoly in the production of phosphate rock. With the development of the more extensive beds in Florida in 1889, South Carolina soon lost its supremacy in the production of this substance. In 1894 the production of rock in Florida exceeded that of South Carolina, and the former State has continued to hold first place since that time. Two varieties of phosphate rock were produced in South Carolina, known as land rock and river rock, the names indicating the sources from which the rock was obtained. The river-bed deposits have practically been worked out and the land deposits are approaching exhaustion. In 1893 the production of phosphate rock

in South Carolina reached its maximum, when the production was 502,564 long tons. In 1911 there were 169,156 long tons, valued at $673,156, and in 1912, 131,490 tons, valued at $524,760. In 1913 the production was only a little more than 20 per cent of that of 20 years before, and amounted to 109,333 long tons, valued at $440,588, a decrease of 22,157 long tons and of $84,172 from 1912.

Exclusive of the raw clay mined and sold, the clay products of South Carolina were valued in 1913 at $583,241, against $704,563 in 1912. By far the greater part of the output is from the brickyards, the value of the common brick produced in 1913 being $530,454 and in 1912, $663,550. South Carolina is one of four States which produces a peculiar quality of clay used in the paper trade and known as "paper clay." None of this product, however, is used within the State, but it is shipped to manufacturers in the North. The production of paper clay in South Carolina in 1913 was 31,568 tons, valued at $120,520, out of a total production of raw clay amounting to 32,222 short tons, valued at $124,240. In 1912 the total quantity of raw clay mined and sold was 47,038 short tons, valued at $162,974, of which 44,372 tons, valued at $157,217, were paper clay. The output of paper clay is principally from Aiken County.

South Carolina is one of two States, North Carolina being the other and more important, in which monazite has been produced in commercial quantities. The production of the two States has exceeded 1,500,000 pounds, and the value has exceeded $160,000. Since 1910, however, on account of the heavy importations from Brazil, production in both States has practically ceased.

The mining of gold in South Carolina has now almost entirely ceased. In 1902 the value of the gold produced in South Carolina exceeded $120,000, the Haile gold mine in Lancaster County being the chief source of the gold. The exhaustion of this property is responsible for the small output of gold at the present time. In 1913 the gold production of South Carolina was 236 fine ounces, valued at $4,881.

Besides the substances discussed in the preceding paragraphs South Carolina has produced some baryte, fuller's earth, occasional gems, lime, manganese ore, mica, mineral waters, sand and gravel, silver, stone, and tin. None, with the exception of the products of the stone quarries, amounts to as much as $50,000, and only one—mineral waters—in 1913 amounted to over $10,000. The stone quarries were the only operations which showed any material increase in production in 1913. The value of the stone produced increased from $263,905 in 1912 to $360,476 in 1913. All of the stone produced is granite. The total value of the mineral products of South Carolina decreased from $1,606,989 in 1912 to $1,464,150 in 1913. The distribution by substances is shown in the following table:

Mineral production of South Carolina in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons	.....	.....	.....	.....	(a)	(a)	.....	.....
Clay products.....do.....	47,638	b$102,974	.....	$704,363	32,222	b$124,249	.....	$583,241
Fuller's earth.....do.....	.....	.....	.....	.....	(a)	(a)	.....	.....
Gems and precious stones.....	.....	.....	.....	.....	.....	.....	.....	20
Gold.....fine ounces (troy).	.....	.....	818	16,915	.....	.....	236	4,881
Lime.....short tons.	.....	.....	(c)	(a)	.....	.....	(c)	(a)
Manganese ore.....long tons.	(a)	(a)	.....	.....	.....	.....	.....	.....
Mica.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Mineral waters.....gallons sold	360,404	70,348	.....	.....	261,412	49,139	.....	.....
Phosphate rock.....long tons.	131,400	574,760	.....	.....	109,333	440,588	.....	.....
Sand and gravel.....short tons.	104,965	14,846	.....	.....	39,730	4,958	.....	.....
Silver.....fine ounces (troy).	.....	.....	47	29	.....	.....	40	24
Stone.....	.....	(c)	.....	c263,905	.....	(c)	.....	c360,476
Tin.....short tons.	.....	.....	.....	.....	.....	.....	3	1,936
Miscellaneous.....	.....	(c)	.....	c 11,623	.....	2,460	.....	16,367
Total value, eliminating duplications.		$1,606,989				$1,464,150		

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

SOUTH DAKOTA.

Gold mining in the Black Hills of Lawrence County is the mainstay of the mining industry of South Dakota. The value of the gold produced in the State represents more than 90 per cent of the total value of its mineral production. In the production of gold South Dakota ranks fifth among the States. In 1913 the production of gold, most of which is from the Homestake mine, amounted to 354,071 fine ounces, valued at $7,319,294, against 381,745 fine ounces valued at $7,891,370, in 1912. The total mineral products of the State decreased in about the same amount as the gold mines, from $8,436,240 in 1912 to $7,888,411. The only other products besides gold which exceeded $100,000 in value are stone and silver, the former amounting to $172,736 in 1913 against $162,295 in 1912. The silver production decreased in value from $126,973 in 1912 to $104,312 in 1913. The principal stone quarried is sandstone or quartzite in Minnehaha County. The only production of lithium ore in the United States is from Custer and Pennington counties in South Dakota, but the quantity and value of the product can not be published.

The other mineral products of the State are clay wares, occasional gems, copper, gypsum, lead, lime, mica, mineral waters, natural gas, sand and gravel, sand-lime brick, tin, and tungsten ore, the total value of these amounting in 1913 to less than $280,000.

The following table gives the quantity and value of the mineral production of South Dakota in 1912 and 1913:

Mineral production of South Dakota in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Clay products				$41,496				$46,685
Copper.....pounds							1,793	278
Gems and precious stones				64				162
Gold...fine ounces (troy)			331,745	7,891,370			354,071	7,319,294
Gypsum.....short tons	(a)			(a)	(a)			(a)
Lead.....do			11	1,028			5	449
Lime.....do			3,914	28,585			4,217	28,610
Lithium.....do	(a)	(a)			(a)	(a)		
Mica				(a)				12,609
Mineral waters, gallons sold	(a)	(a)			(a)	(a)		
Natural gas		(a)				(a)		
Sand and gravel, short tons	545,622	$69,348			1,098,837	$85,306		
Sand-lime brick				14,395				(a)
Silver..fine ounces (troy)			203,460	126,947			172,702	104,312
Stone		(b)		b 162,295		(b)		b 172,736
Tin.....short tons							1	660
Tungsten ore (60 per cent concentrates), short tons							(a)	(a)
Miscellaneous		37,741		62,367		46,211		67,099
Total value, eliminating duplications.	$3,436,240				$7,888,411			

a Value included under "Miscellaneous."
b Stone sold rough included in derived product.

TENNESSEE.

The most important mineral product of Tennessee is coal, the value of the annual production of which is something over one-third the total value of the mineral products of the State. Second in importance among the mineral products which are included in the total value is copper, which represents about 14 per cent of the total value, while the stone quarries, chiefly marble, contributed a little less than 10 per cent. The production of copper in Tennessee in 1913 was not materially different from that of the preceding year, the production showing an increase from 18,483,173 pounds to 19,390,750 pounds, but the value decreased from $3,049,724 in 1912 to $3,005,566 in 1913. The value of the pig iron produced in Tennessee exceeds that of the copper product, but is not included in the total, as the basis of iron production is the output of iron ore. The total value of the mineral products of Tennessee in 1913 was $21,052,931, against $19,362,209, the gain in 1913 being principally in the output of coal, stone, and zinc.

The production of coal, the most important mineral product of the State increased from 6,473,228 short tons, valued at $7,379,903, in 1912 to 6,903,784 short tons, valued at $7,883,714. All of the coal-producing counties are in the central eastern part of the State, which is crossed in a northeast-southwest direction by the coal areas of the Appalachian system. The principal producing counties, Campbell and Claiborne, are at the northern end of the Tennessee coal field. This section produces the celebrated Jellico coal, highly prized as a steam and domestic fuel. Other important coal-producing

counties are Marion, Anderson, Morgan, Hamilton, Grundy, Overton, Scott, Rhea, Roane, and White. All of the coal produced in the State is bituminous in character, some of it possessing excellent coking quality. Coke is made in eight counties, and is consumed in the iron furnaces at Rockwood, at Dayton, and in the vicinity of Chattanooga. The production of coke decreased from 370,076 short tons, valued at $951,853, in 1912 to 364,578 short tons, valued at $925,430, in 1913. The output of the blast furnaces, which is not included in the total mineral production, decreased from 339,397 long tons, valued at $4,171,153, in 1912 to 270,481 long tons, valued at $3,576,485, in 1913. All of the iron ore mined in Tennessee is used at blast furnaces within the State, with fuel which is produced within the State. The iron ore occurs in close proximity to the coking coals, and was mined chiefly in Roane, Lewis, Lawrence, and Monroe counties. The ores mined are principally hematite and brown ore, approximately 60 per cent being hematite and 40 per cent brown ore. In 1912 the commercial product, that is, the ore sold or used, was 416,885 long tons, valued at $564,443, and in 1913 it was 364,092 long tons, valued at $493,556.

Tennessee is the only one of importance among the eastern States in the production of copper, and ranks ninth in this respect among the States, but when compared with the great copper production of Arizona, Montana, and Michigan the output of copper in Tennessee appears unimportant. The entire production of the State is from pyritic ores mined in Polk County and smelted at Ducktown. The agitation in the last three years against the emission of sulphur-laden fumes from the smelter stacks and the efforts of the operators to control them have resulted in the construction of plants for the recovery in the form of acid of the sulphur contained in the ore. The plant of the Tennessee Copper Co. was described in the report on the production of sulphur, pyrite, and sulphuric acid in Part II of Mineral Resources of the United States for 1911. This plant was begun in 1906, enlarged in 1910, and has a capacity of 180,000 to 200,000 tons of 60° Baumé acid annually. Its production of acid in 1913 was a fair test of the capacity of the plant. The Ducktown Sulphur, Iron & Copper Co. (Ltd.) has also installed an acid-recovery plant at its works. Details of production are not published, however, as these are the only producers of smelter acid in the State.

The mining of phosphate rock and the quarrying of stone are rivals for third place in importance among Tennessee's mineral industries, the quarries having considerably the better of it in 1913, with a total value of $2,062,686, a gain of over $400,000 from $1,656,812 in 1912. The principal quarry products are marble and limestone. Tennessee marbles have a high reputation for interior decoration, and approximately 75 per cent of the entire output of marble is sold for that purpose. Limestone is used chiefly for road making, railroad ballast, concrete, and furnace flux. The principal marble-producing counties are Blount and Knox; Hawkins, Loudon, and Union counties also furnish small quantities. Those producing the larger part of the limestone are Campbell, Carter, Cheatham, Coffee, Davidson, Franklin, Giles, Grainger, Hamilton, Jefferson, Knox, Marion, Maury, Montgomery, Rhea, Roane, Sullivan, Trousdale, and Wilson. The increase in Tennessee's stone production was entirely from the marble quarries, the value of the output of which increased from $974,733 in

1912 to $1,416,952 in 1913. The value of the limestone decreased from $673,329 to $643,586.

The production of phosphate rock in 1913 amounted to 451,559 long tons, valued at $1,774,392, which was an increase of about 7 per cent in quantity and about 9 per cent in value over the output of 1912. Extensive beds of phosphate rock occur in the central part of the State in Hickman, Maury, Williamson, Perry, and Lewis counties, and are of three types—brown, blue, and white rock, the first of which is by far the most important commercially. The discovery of the phosphatic character of this rock was made in 1894, and Tennessee now ranks second, with Florida first, in the production of this mineral substance.

The value of clay products, which came fifth in the list of mineral products of the State, decreased from $1,501,016 in 1912 to $1,493,085 in 1913. The chief clay products are common brick, sewer pipe, vitrified brick, front brick, and pottery, and of the total values given above, those for pottery were in 1912 $173,166 and in 1913 $145,100. The principal counties in the production of brick are Davidson, Shelby, Hamilton, and Knox. Tennessee is an important producer of ball clay, a high-grade clay used in the manufacture of porcelain and white ware. In the quantity of ball clay produced Tennessee holds first place, though falling behind Florida in the value of the product. The total quantity of clay mined in the State and sold as clay was 56,304 short tons, valued at $124,572 in 1913. Most of the clay sold in its raw state is shipped to other States for manufacture.

One of the significant features connected with the mineral industry of Tennessee in 1913 was the increase in the production of zinc, the recoverable content of the ores mined in the State having increased from 2,191 short tons, valued at $302,310, in 1912 to 5,583 short tons, valued at $625,296, in 1913. Zinc mining and smelting developments have been part of the history of the State for the last two years, and are located at Mascot, in Knox County, the mill for the treatment of the ores having been completed the latter half of 1912.

The other commercial products of Tennessee are barytes, bauxite, cement, gold, lime, mineral paints, mineral waters, natural gas, sand and gravel, silica (quartz), silver, and tripoli.

The distribution, by substances, of the mineral products of Tennessee in 1912 and 1913 is shown in the following table:

Mineral production of Tennessee in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Barytes..short tons..	3,718	$8,682	.....	.....	2,098	$3,568	.....	.....
Bauxite..long tons...	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons.....	56,253	b 123,523	.....	$1,501,016	56,304	b 124,572	.....	$1,493,085
Coal.....short tons..	6,473,228	7,379,903	.....	.....	6,903,784	7,883,714	.....	.....
Coke.....do....	.....	.....	370,076	b 951,853	.....	.....	364,578	b 925,430
Copper.....pounds..	.....	.....	18,483,173	3,049,724	.....	.....	19,390,750	3,005,566
Ferro-alloys, long tons.....	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Gold, fine ounces (troy).....	.....	.....	400	8,265	.....	.....	367	7,595
Iron ore...long tons..	416,885	564,443	.....	.....	364,092	493,556	.....	.....
Iron, pig.....do....	.....	.....	339,397	b 4,171,153	.....	.....	270,481	b 3,576,485
Lime.....short tons..	.....	.....	101,339	316,364	.....	.....	92,427	288,400
Mineral paints, natural pigments, short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold.....	796,568	53,560	.....	.....	1,088,034	64,905	.....	.....
Natural gas.....	.....	375	.....	.....	.....	600	.....	.....
Phosphate rock, long tons.....	(a)	(a)	.....	.....	451,559	1,774,392	.....	.....
Sand and gravel, short tons.....	1,181,967	516,298	.....	.....	828,633	288,900	.....	.....
Silica....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Silver, fine ounces (troy).....	.....	.....	89,893	55,284	.....	.....	108,105	65,295
Stone.....	.....	(c)	.....	c 1,656,812	.....	(c)	.....	c 2,062,686
Sulphuric acid (60° Baumé) d, short tons.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Tripoli.....	.....	.....	.....	.....	.....	.....	.....	(a)
Zinc.....short tons..	.....	.....	2,191	302,310	.....	.....	5,583	625,296
Miscellaneous.....	.....	1,703,605	.....	2,504,229	.....	73,148	.....	3,152,907
Total value, eliminating duplications..	$19,362,209				$21,052,931			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.
d From copper smelting.

TEXAS.

Texas, the largest of all the States in area and fifth in the number of inhabitants, ranks nineteenth in the value of its mineral production. In each of the last two years Texas has advanced in the rank of mineral producing States, from twenty-fourth in 1911 to twenty-first in 1912 and to nineteenth in 1913. In the percentage of its increase in 1913 over 1912 Texas was exceeded by only two other States, its northern neighbor, Oklahoma, which, on account of the sharp advance in the price of petroleum, showed a gain over 1912 of nearly 50 per cent, and Oregon. The value of the mineral products of Texas showed an increase of 38.9 per cent. In Oklahoma, as in Oregon, the increase in 1913 was due to the advance in the price of one substance; in Texas, increases were shown in the production of all of the products which contributed materially to the total value, but was especially emphasized, as in Oklahoma, by the increase in the production of petroleum. Texas holds first place as a producer of

one mineral substance (asphalt) and ranks second in the production of quicksilver. Since the sensational strike of petroleum at Beaumont in 1901 that substance has had first place in the mineral products of the State, and Texas now ranks fourth among all the States in the quantity of petroleum production, and seventh with respect to the value of the product. The value of the petroleum product in Texas in 1913 represented a little more than 46 per cent of the total for the State. The production increased from 11,735,057 barrels, valued at $8,852,713 in 1912, to 15,009,478 barrels, valued at $14,675,593, in 1913. The increased production was almost entirely from the Electra field in the northern part of the State, where a large amount of development and wildcatting has been carried on for the last two years. The production from the coastal fields decreased from 6,459,528 barrels in 1912 to 5,825,226 barrels in 1913, but the value increased from $4,739,887 to $5,550,408. In the northern fields the production increased from 5,275,529 barrels in 1912 to 9,184,252 barrels in 1913, with an increase in value from $4,112,826 to $9,125,185. The Electra field alone increased nearly 4,000,000 barrels, from 4,227,104 barrels in 1912 to 8,134,624 barrels in 1913, with an increase in value of over $4,800,000, from $3,340,828 in 1912 to $8,142,797 in 1913. The average value per barrel for Electra oil advanced from 79 cents in 1912 to $1 in 1913. There was also considerable development in the Henrietta field, but the output there was relatively insignificant compared with the output of the Electra field. The possibilities for oil development are more widely scattered over Texas and the indications for wildcatting are more promising than in any other State. Hence the chances for further extension are excellent.

Second in importance among the mineral products of Texas, reckoned by the value of output, is coal, including lignite or brown coal, the combined production of these amounting in 1913 to 2,429,144 short tons, valued at $4,288,920, against 2,188,612 short tons, valued at $3,655,744 in 1912. Texas is the only State in the Union that produces considerable quantities of both bituminous coal and true lignite, or brown coal. The areas of bituminous coal are much less in extent than those of lignite. The production of bituminous coal is something more than one-half of the total output in quantity and about 75 per cent of the total value. In 1913 the production of bituminous coal mined in Eastland, Erath, Maverick, Palo Pinto, Webb, Wise, and Young counties, amounted to 1,197,207 short tons, valued at $3,184,161. The production of lignite amounted to 1,181,156 short tons, valued at $1,104,759. Lignite mining operations have been carried on in Anderson, Bastrop, Fayette, Henderson, Hopkins, Houston, Lee, Leon, Medina, Milam, Rains, Robertson, Shelby, Titus, Van Zandt, and Wood counties. The lignite areas extend in a belt from the Sabine to the Rio Grande, and the production is limited at present to 11 of these counties, among which the principal ones are Milam and Wood. The total area which is believed to be underlain by lignite is about 55,000 square miles, of which the developed areas are about 2,000 square miles. The known bituminous areas underly about 8,200 square miles; also 5,300 square miles about which little is known may contain coal. The bituminous areas are somewhat scattered, the larger fields being in the cen-

tral part of the State, with two smaller areas bordering on the Rio Grande.

The only other products which contribute as much as $1,000,000 to the total value are asphalt, cement, clay, and natural gas. The most important of these is the clay-working industry, which in 1913 contributed wares valued at $3,049,349, an increase from $2,886,068 in 1912. The principal clay products are common brick, sewer pipe, front brick, pottery, and vitrified brick, the first named constituting in 1913 about 60 per cent of the total. The principal clay-working counties are Ellis, Wilson, Bastrop, and Bowie. An interesting incident of fire brick manufacture in Texas is that in Brewster County clay is used in the yard 130 miles from the railroad for making brick used in the quicksilver furnaces of the Terlingua district. Kaolin, from which excellent china and procelain wares have been made, occurs and has been mined in Edwards County. Extensive deposits of fuller's earth have been found in Burleson, Fayette, Smith and Washington counties, some being produced in Fayette county in 1912 but none in 1913.

The manufacture of Portland cement is an industry barely five years old at the end of 1913. The construction work of the plants was begun in 1907, and in 1908 the total production of the State was 500,000 barrels, In 1911 it exceeded 1,500,000 barrels, exceeded 1,750,000 barrels in 1912, and amounted to 2,108,737 barrels in 1913. The value of the cement produced in Texas in 1913 was $2,663,063, an increase of over $600,000, from $2,062,124 in 1912. Raw materials for the manufacture of cement are abundantly distributed throughout the State. The present operations are confined to four plants—two near Dallas and one each at San Antonio and El Paso.

The value of the natural gas production also showed a substantial increase—from $1,405,077 in 1912 to $2,073,823 in 1913.

The asphalt production of Texas, which is principally residue obtained from the heavy asphaltic oils, amounted to 122,026 short tons, valued at $1,970,354 in 1913, against 88,097 short tons, valued at $1,384,640, in 1912. In addition to this there was a small quantity of natural asphalt produced, but as there were less than three producers in 1913 the figures are not published.

The only products of any importance which did not show an increase in value in 1913 over 1912, were gypsum and salt. Even in the case of gypsum there was an increase in the quantity of the crude material mined from 160,863 short tons in 1912 to 161,090 tons in 1913; but the value of the output, most of which was sold as calcined plaster, decreased from $356,579 to $345,749. The principal gypsum operations are at Acme, in Hardeman County, and at Hamlin, in Fisher County. The production of salt decreased from 373,064 barrels, valued at $290,328, to 355,529 barrels, valued at $278,008. The decrease in the salt production was due to the destruction by fire of one of the salt-making establishments at Colorado.

The principal quarry product is limestone, produced in Bell, Bexar, Comal, Coryell, El Paso, Erath, Grayson, Guadalupe, Jack, Jones, Kaufman, McCulloch, Nonan, Palo Pinto, Stephens, Travis, and Williamson counties, and is used for building, for foundations, for curbing and flag stones, for road making, for concrete, and for flux. Granite is produced in Burnet, El Paso, and Llano counties. The

red granite of Burnet County has few equals in attractiveness in this country. The total value of the stone produced in Texas in 1913 was $725,106, against $680,365 in 1912. About 80 per cent of the total value was in the output of limestone.

Other mineral products of the State are copper, occasional gems, a small amount of gold, iron ore, lead, lime, mineral waters, sand and gravel, sand-lime brick, silver, sulphur, and zinc. Sulphur operations, similar to the methods employed at Sulphur City, La., were begun at Bryan Heights in Brazoria County in 1913, but as the entire output is by one company the statistics of production are not published.

The total value of the mineral production increased about 40 per cent, from $22,797,015 in 1912 to $31,666,910 in 1913, the larger part of the increase being, as shown below, due to the increased production and higher value of petroleum. The distribution of the mineral products of Texas in 1912 and 1913, by substances, is shown in the following table:

Mineral production of Texas in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt..short tons..	6,435	$19,626	88,097	$1,384,640	(a)	(a)	122,026	$1,970,354
Cement.....barrels..	.....	.....	1,762,780	2,062,124	.....	.....	2,108,737	2,663,063
Clay products, short tons.....	1,342	b 6,442	.....	2,886,068	2,746	b $9,465	.....	3,049,349
Coal.....short tons..	2,188,612	3,655,744	.....	.....	2,429,144	4,288,920	.....	.....
Copper.....pounds..	.....	.....	721	119	.....	.....	34,665	5,373
Fuller's earth, short tons.....	(a)	(a)	.....	.....	.....	.....	.....	.....
Gems and precious stones.....	.....	.....	.....	145	.....	.....	.....	344
Gold, fine ounces (troy).....	.....	.....	3	63	.....	.....	16	340
Gypsum, short tons..	160,863	.....	.....	356,579	161,090	.....	.....	345,749
Iron ore...long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Lead.....short tons..	.....	.....	33	2,939	.....	.....	113	9,910
Lime.....do....	.....	.....	45,529	236,101	.....	.....	45,897	255,893
Mineral waters, gallons sold.....	1,292,992	151,395	.....	.....	1,187,612	132,488	.....	.....
Natural gas.....	.....	1,405,077	.....	.....	.....	2,073,823	.....	.....
Petroleum...barrels..	11,735,057	8,852,713	.....	.....	15,009,478	14,675,593	.....	.....
Quicksilver...flasks..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Salt.....barrels..	.....	.....	373,064	290,328	.....	.....	355,529	278,008
Sand and gravel, short tons.....	716,468	384,942	.....	.... ..	870,943	455,908	....	.....
Sand-lime brick.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Silver, fine ounces (troy).....	.....	.....	406,067	249,731	.....	.....	427,553	258,242
Stone..... ..	.....	(c)	.....	c 680,365	.....	(c)	.....	c 725,106
Sulphur..long tons..	.....	.....	.....	.....	(a)	(a)	.....	.....
Zinc.....short tons..	.....	.....	119	16,422	.....	.....	326	36,546
Miscellaneous.....	.....	13,211	.....	148,683	.....	267,137	.....	174,764
Total value, eliminating duplications..	$22,797,015				$31,666,910			

a Value included under "Miscellaneous."
b Value not included in total value.
c Stone sold rough included in derived product.

UTAH.

Utah is unique in the diversity of its metal production, particularly of precious and semiprecious metals. It does not rank first in the production of any of these, but it stands well among the leaders in the production of gold, silver, copper, lead, zinc, and vanadium minerals. It ranks third in the production of copper, lead, and silver; seventh in the production of gold; and ninth in the production of zinc. Over 45 per cent of the total production of the State in 1913 was from the copper mines of Bingham district in Lake County, the Tintic district in Juab County, and the San Francisco district in Beaver County. Fully 80 per cent of the copper produced, however, is from Lake County. The recoverable copper content of the ores mined in Utah in 1913 was 161,445,962 pounds, valued at $25,024,124, against 137,307,485 pounds, valued at $22,655,735, in 1912. The silver production, which ranks next to copper in value, is principally from Juab, Summit, Wasatch, and Utah counties, with smaller quantities from Salt Lake, Beaver, and Tooele counties. The production of silver decreased in 1913, the recoverable content of the ore mined being 13,835,903 fine ounces, valued at $8,509,080, in 1912, and 13,084,835 fine ounces, valued at $7,903,240, in 1913. The silver-producing counties are also the chief producers of lead, and one-half of the silver production and 90 per cent of the lead production are from silver-lead ores. The value of the lead production in 1913 closely approximated that of silver, whereas in 1912 the value of the silver was in excess of that of lead by more than one-third. The recoverable lead content of the ores mined in Utah increased from 70,156 short tons, valued at $6,314,001, in 1912, to 83,063 tons, valued at $7,309,579, in 1913.

Gold, the fourth metal in importance, but not the fourth mineral, as it is exceeded by coal, showed in Utah the same decreasing tendency as was apparent throughout most of the gold mining regions in 1913, and declined from 206,360 fine ounces, valued at $4,265,851, to 172,468 fine ounces, valued at $3,565,229, in 1913. The principal gold-producing counties are Juab, Salt Lake, and Tooele, with smaller quantities from Utah, Summit, Beaver, Wasatch, Piute, Box Elder, Iron, Washington, and Millard counties. There was also a small scattered placer production from other counties. About 35 per cent of the gold obtained is from dry or siliceous ores, but most of the output is obtained in the refining of copper. Some of the lead and zinc ores also yield gold.

The zinc production is principally from middlings and concentrates from the Park City district, and amounted in 1913 to 9,429 short tons of metallic zinc, valued at $1,056,038. This was an increase in quantity, but decrease in value from 1912, when the quantity recovered was 8,534 short tons, valued at $1,177,635.

The total value of the metal production of Utah in 1913, including a small output of iron ore and vanadium ores, was $44,916,348 out of a total value of all mineral production of $53,606,520. In 1912 the metal production was valued at $42,944,888 out of a total of $51,004,942.

The most important of the nonmetallifereous products is coal, and more than one-half of the value of nonmetals produced in the State is from the coal mines. The principal coal-producing county is

Carbon, which contains a part of the Uinta coal basin, extending through eastern Utah almost to the central part of Colorado. The developments are principally along the line of the Denver & Rio Grande Railroad. Some of the Carbon County coal possesses coking qualities, and considerable quantities of coal (chiefly slack) are made into coke annually. The production of coal in Utah increased from 3,016,149 short tons, valued at $5,046,451, in 1912, to 3,254,828 tons, valued at $5,384,127, in 1913. Of the total production in 1913, Carbon County produced 2,830,102 tons, or nearly 90 per cent.

The manufacture of Portland cement, which is of very recent development in Utah, having been begun in 1910, amounted in 1913 to 950,469 barrels, valued at $1,233,421, against 760,668 barrels, valued at $937,119, in 1912. The principal clay products of the State are common brick and front brick, with smaller quantities of vitrified brick, drain and other tile, and a little pottery. The value of the clay products, exclusive of pottery, decreased slightly, from $724,978 in 1912 to $708,906 in 1913.

The principal stone quarried is limestone, a large part of which is used for flux in smelters, though some is used for foundation work and for building. The limestone quarries are located principally in Cache, Morgan, Salt Lake, San Juan, San Pete, Tooele, and Utah counties. Relatively small quantities of sandstone, granite, and marble are also produced in the State.

The other mineral products are asphalt, gems (occasional), grindstones, gypsum, lime, mineral waters, phosphate rock, pumice, salt, sand and gravel, and scythestones. The distribution of the production by substances during the last two years is shown in the following table:

Mineral production of Utah in 1912 and 1913.

Product.		1912				1913			
		Raw.		Derived.		Raw.		Derived.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asphalt	short tons	32,514	$633,069			30,810	$529,341		
Cement	barrels			760,668	$937,119			950,469	$1,233,421
Clay products	short tons	(a) (b)	(a) (b)		c 724,978	4,969	b 11,708		c 708,906
Coal	do	3,016,149	5,046,451			3,254,828	5,384,127		
Coke	do			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Copper	pounds			137,307,485	22,655,735			161,445,962	25,024,124
Gems and precious stones					8,325				7,505
Gold	fine ounces (troy)			206,360	4,265,851			172,468	3,565,229
Grindstones					(a)				
Gypsum	short tons	45,665			143,304	(a)			(a)
Iron ore	long tons	7,280	22,586			14,690	44,628		
Lead	short tons			70,156	6,314,001			83,063	7,309,579
Lime	do			20,325	111,291			8,680	56,704
Mineral waters	gallons sold	(a)	(a)			(a)	(a)		
Phosphate rock	long tons	(a)	(a)						
Pumice	short tons					(a)	(a)		
Salt	barrels	56,836	29,393	226,457	125,341	29,721	12,370	300,722	179,316
Sand and gravel	short tons	76,850	28,595			108,758	16,481		
Scythestones					(a)				
Silver	fine ounces (troy)			13,835,903	8,509,080			13,084,835	7,903,240
Stone			(d)		d 249,782		(d)		d 415,471
Uranium and vanadium ores	short tons			(a)	(a)			(a)	(a)
Zinc	do			8,534	1,177,635			9,429	1,056,038
Miscellaneous			27,417		1,507,862		3,968		1,576,702
Total value eliminating duplications			$51,004,942				$53,606,520		

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of pottery, value for which is included under "Miscellaneous."
d Stone sold rough included in derived product.

VERMONT.

Vermont, like the other New England States, bases its claim to distinction as a mining State upon the output of its marble, granite, and slate quarries. Vermont is the leading State in the production of marble and granite, and the second in the production of slate. Exclusive of the slate production, the stone quarries contributed more than 75 per cent of the total mineral product of the State, value considered; and when the product of the slate quarries is added to that of the marble and granite, the total quarry product is found to be over 90 per cent of the total value of the mineral production of the State. The marble quarries are chiefly in Rutland County in the west-central part of the State and in the immediate vicinity of Rutland and Proctor, with smaller quarries in Franklin County. It has also been quarried in Addison, Bennington, Chittenden, and Washington counties. The granite quarries are principally in the central and northern portions of the State, northeast and southeast from the marble-producing region. The principal quarries, both in number and size, are in the vicinity of Barre, in Washington County, with important operations also in Caledonia and Windsor counties and less important ones in Essex, Orange, and Windham counties. The slate production is almost exclusively from Rutland County. The total production of stone, exclusive of slate, in Vermont in 1913, was valued at $7,313,355, of which slightly more than 50 per cent, or $3,782,235, was from the granite quarries, and something less than 50 per cent ($3,513,405) was from the marble quarries. In 1912 the total production was valued at $6,554,851, of which $3,494,253 was the value of the marble and $3,074,306 the value of the granite. A small quantity of limestone was also produced in both years. In considering the granite-quarrying operations of Vermont it should be understood that a large part of the stone produced is sold by the quarrymen in the rough. Three fourths of the granite quarrymen sell their product in the rough, and values are given for the rough stone. It is only when stone is dressed at the quarries that higher value of the dressed stone is given in the Survey reports. The result of this condition is that the unit of output of granite of Vermont frequently shows lower value than that of many other States, which is due simply to the fact that such a large proportion of the product is dressed in yards not connected with the quarries. Considerably more than three-fourths of the granite quarried in Vermont is used for monumental purposes, and 20 per cent for building. Marble is used largely for interior work, but is also used for building and other purposes. The slate production for 1913 was valued at $1,697,820, against $1,849,975 in 1912. Including lime and slate the total value of the quarried products in 1913 was $9,182,313 out of a total value of all products of $9,647,985. In 1912 the quarried products were valued at $8,610,235 out of a total of $9,087,560.

Other products of the State are asbestos, manufactured clay wares, a small quantity of copper, gold and silver, feldspar, mineral paints, mineral waters, sand and gravel, scythestones, talc, and soapstone. The distribution of the mineral production of Vermont during 1912 and 1913 by substances is shown in the following table:

Mineral production of Vermont in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	(a)	(a)	.....	.....	.....	.....	.....	.....
Clay products.....do....	(a) (b)	(a) (b)	.....	$79,266	(a) (b)	(a) (b)	.....	$94,773
Copper.....pounds..	.....	.....	.....	.....	.....	.....	13,900	2,155
Feldspar.....short tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Gold..fine ounces (troy)..	.....	.....	.....	.....	.....	.....	.....	3
Lime.....short tons..	.....	.....	39,572	205,409	.....	.....	32,803	171,138
Mineral paints, natural pigments...short tons..	.....	.....	531	6,346	.....	.....	(a)	(a)
Mineral waters, gallons sold.....	21,000	$8,280	.....	.....	17,725	$7,068	.....	.....
Sand and gravel, short tons.....	97,476	13,296	.....	.....	116,765	15,045	.....	.....
Scythestones.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Silver..fine ounces (troy)..	.....	.....	.....	.....	.....	.....	105	63
Slate.....	.....	.....	.....	1,849,975	.....	.....	.....	1,697,820
Stone.....	.....	(c)	.....	c6,554,851	.....	(c)	.....	c7,313,355
Talc and soapstone, short tons.....	.....	.....	42,413	275,679	.....	.....	45,547	327,375
Miscellaneous.....	.....	(c)	.....	c 124,504	.....	36,892	.....	18,401
Total value, eliminating duplications.....	$9,087,560				$9,647,985			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

VIRGINIA.

Virginia ranks high among the States in the variety of mineral substances produced on a commercial scale, but somewhat low (twenty-eighth in 1912 and twenty-ninth in 1913) in the value of the production. Virginia is the leading State in the production of iron pyrite used in the manufacture of sulphuric acid, and in the production of manganese ore and millstones, and is the only State in which rutile is produced. It also ranks first in the production of soapstone, most of which, before being marketed, is manufactured into heat and chemical resisting articles, such as hearthstones, mantles, griddles, sinks, etc.

The product of chief value, however, in the State is coal, which represents something more than 50 per cent of the total value of the mineral production. As noted in the chapter on the production of coal (pt. 2, p. 203), the record of coal mining in Virginia in 1913 is an interesting one. The quantity of coal produced showed an increase of nearly 1,000,000 tons over 1912, and something over 1,000,000 tons in the quantity mined by machines. The average number of working days was unusually large; the average production per man was the largest in the history of the State; the quantity of coal shot off the solid was reduced to the same extent that the machine-mined product was increased; the number of fatal accidents was reduced more than two-thirds, and there was not an instance of labor disaffection reported. The production in 1913 amounted to 8,828,068 tons, valued at $8,952,653, against 7,846,638 tons, valued at $7,518,576, in 1912. The principal increase in 1913, as in 1912, was in Wise County, whose output showed a gain of over 600,000 tons; Russell County,

the latest in the coal-mining operations to be developed, also showed a substantial increase of over 200,000 tons; and Tazewell, the oldest of the important producing counties, showed an increase of nearly 150,000 tons. The only other coal-producing county of any importance is Lee, whose output amounts to about three-fourths of a million annually, and showed a small increase in 1913. Small quantities of coal were also produced in Henrico County (Richmond Basin), and in Montgomery and Pulaski counties, the output of the last two counties being designated as semianthracite. Virginia is credited with having produced the first coal mined in the United States from a small basin contained in Henrico and Chesterfield counties, in the eastern part of the State, near Richmond. Coal was known to exist in this locality as early as 1710, and before the close of the century shipments were made from this region to some of the Northern States. With the development of the more abundant and higher grade coals of the Appalachian region the industry in the eastern part of the State lagged, and for a number of years the mines were not in operation. They were reopened in 1910, and in 1911 were again at a producing stage. The chief production of coal, however, is in Wise, Tazewell, Lee, and Russell counties, in the southwestern portion of the State, the area of which belongs to the Appalachian region. The mining of coal in southwestern Virginia was coincident with the first Survey report on the mineral resources of the United States. The first shipments from the Pocahontas district, in which Tazewell County lies, were made to Norfolk in 1883. In 1888 the production exceeded 1,000,000 tons. In 1892 the Wise County fields were opened, and in 1897 the production from this new district exceeded that of Tazewell County. The mines in Lee County were opened in 1905, and development of properties in Russell County has been active in the last two or three years. The production in 1912 was the maximum up to that year. The old Gayton mines in Henrico County were reopened in 1910, and have produced some coal in each of the last three years.

Virginia's production of pig iron, the value of which is not included in the total mineral production, amounted in 1913 to 380,508 long tons, valued at $5,310,167 compared with 328,961 tons, valued at $4,364,708 in 1912. The production of coke, whose value is also excluded from the total, increased from 967,947 short tons, valued at $1,815,975, to 1,303,603 tons, valued at $2,840,275. No other mineral product of the State, either primary or secondary, had a value, either in 1912 or in 1913, exceeding $2,000,000. The nearest approach to this figure is the value of the clay products. These in 1913, exclusive of pottery, amounted to $1,705,651, a decrease from $1,874,174 in 1912. Brick are made from the residual clays dug at one or more places in nearly every county of the Piedmont section. Common brick is the most important of the clay products, representing about 80 per cent of the total value. The principal producing county is Alexandria (opposite the city of Washington), with Henrico County (in which is Richmond) a close second in quantity and first in value. Fire clay is dug and used at the Catawba furnace in Botetourt County; and is also dug in Appomattox, Buckingham, Chesterfield, Cumberland, Montgomery, Orange, Powhatan, Rockbridge, and Wythe counties. Small quantities of kaolin are mined in Henry County, and it has been reported in at least a dozen counties, most of them in the Piedmont region.

Third in importance among the primary mineral products of the State is stone, of which the chief varieties quarried are granite and limestone. The principal operations for granite are in the vicinity of Richmond, in Henrico and Chesterfield counties, with smaller quantities from Alexandria, Campbell, Dinwiddie, Fairfax, Fluvanna, Goochland, Greenesville, Loudoun, Lunenburg, Nelson, Pittsylvania, Prince William, and Stafford counties. There are about 25 granite-producing quarries. Limestone is abundant throughout the Shenandoah Valley, from Frederick County on the north to Wise County on the south. It also occurs in some of the Piedmont counties, and is used for building purposes. It is quarried in Botetourt, Loudoun, Roanoke, Washington, and Wythe counties. Some of the limestone of the Shenandoah Valley is particularly valuable for blast-furnace flux, for which purpose it is quarried in Alleghany, Botetourt, Pulaski, Rockbridge, Wise, and Wythe counties. Most of the limestone produced for fluxing purposes in the "Valley of Virginia" is from the portion of the valley lying in West Virginia. The total value of the quarry products of Virginia increased from $877,746 in 1912 to $1,063,782 in 1913. All of this increase was in the production of limestone. The value of the granite decreased from $470,657 in 1912 to $462,162 in 1913, whereas the value of the limestone increased from $403,069 in 1912 to $598,032 in 1913. A small quantity of sandstone and marble was also produced in the State in 1913. The combined values of these, however, were less than $4,000.

In addition to the limestone produced and sold as such, the quantity that went to the limekilns produced 236,665 short tons of lime, valued at $805,443, in 1913, a marked increase from 1912, when the lime production amounted to 124,711 short tons, valued at $488,628.

The production of iron ore, which had shown a decided falling off—more than 50 per cent from 1910 to 1912—recovered somewhat in 1913, but was still much below that of any of the several years immediately preceding 1912. The iron ore produced came chiefly from Botetourt, Pulaski, Wythe, Alleghany, Roanoke, Pittsylvania, and Craig counties, and amounted in 1913 to 492,649 long tons, valued at $983,279, against 412,520 tons, valued at $903,130, in 1912.

In the production of iron pyrite (used in the manufacture of sulphuric acid) Virginia stands well at the head of the list, with nearly 50 per cent of the total production in 1912 and 1913, and slightly in excess of that proportion in 1910. The production decreased somewhat, from 162,478 long tons, valued at $621,219 in 1912, to 148,259 tons, valued at $587,041, in 1913. The pyrite production is from Louisa, Carroll, and Prince William counties, in the order named.

The soapstone production, in which Virginia also ranks first, is from quarries in a belt extending in a northeast-southwest direction through the central part of the State, and includes Fairfax County, on the north, and Orange, Nelson, and Albemarle counties, on the south. The production, including that of talc, was 26,487 short tons, valued at $615,558, in 1913, against 25,313 tons, valued at $576,473, in 1912. The values in each case are those for the condition in which the product is first sold, which in Virginia is largely in manufactured articles.

In the total value of commercial mineral waters sold Virginia ranks fifth among the States. This product would apparently be

one of steady production and consumption, but the values seem to show considerable variation. In 1911 the mineral water sold was reported at 2,474,918 gallons, valued at $298,701; this increased to 2,762,319 gallons, valued at $349,255, in 1912, and the sales further increased to 2,873,288 gallons in 1913, but the value decreased to $298,473.

In former years Virginia was of considerable importance in the production of lead and zinc. Lead mining in the State began more than 150 years ago, the first operations being conducted at Austinville, in Wythe County. Zinc mining began at a much later date, the ores at Bertha, also in Wythe County, being discovered in 1876; mining began in 1879. The metal was of exceptional purity and was used largely by the United States Government as an alloy in coining. These deposits are now practically exhausted. The zinc content of the ores mined in Virginia in 1912 amounted to only 249 short tons, valued at $34,309, and the lead content of the ores was 235 short tons, valued at $21,106. Although the production of both metals was small, there was a considerable increase in the output in 1913, the recoverable lead content of the ores mined amounting to 816 tons, valued at $71,808. The zinc content of the ores mined in the State in 1913 was more than 10 times that of 1912 and amounted to 2,719 short tons, valued at $304,528.

In addition to the mineral substances discussed in the preceding paragraphs the following commercial products are obtained in the State: Barytes, cement, copper, feldspar, occasional gems, gold, gypsum, infusorial earth, mica, mineral paints, salt, sand and gravel, silver, and slate.

The total mineral production of the State increased in value from $14,995,842 in 1912 to $17,178,580 in 1913, distributed by substances as shown in the following table:

Mineral production of Virginia in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Barytes....short tons	(a)	(a)			(a)	(a)		
Briquets, fuel....do			(a) (b)	(a) (b)			(a) (b)	(a) (b)
Cement.....barrels			(a)	(a)			(a)	(a)
Clay products, short tons	2,599	b $2,006		c $1,874,174	2,789	b $2,484		c $1,705,651
Coal.....short tons	7,846,638	7,518,576			8,828,068	8,952,653		
Coke.....do			967,947	b 1,815,975			1,303,603	b 2,840,275
Copper.....pounds			112,835	18,618			56,287	8,724
Feldspar...short tons	(a)	(a)						
Ferro-alloys.long tons			(a) (b)	(a) (b)				
Gems and precious stones				35				30
Gold, fine ounces (troy)			10	218			29	604
Gypsum...short tons	(a)			(a)	(a)			(a)
Infusorial earth				(a)				(a)
Iron ore.....long tons	412,520	903,130			492,649	983,279		
Iron, pig.....do			328,961	b 4,364,708			380,508	b 5,310,167
Lead.....short tons			235	21,106			816	71,808
Lime.....do			124,711	488,628			236,665	805,443
Manganese and manganiferous ore, long tons	3,104	19,180			d 4,048	d 40,480		
Mica								5,150
Millstones				25,866				23,530
Mineral paints:								
Natural pigments, short tons			1,181	10,853			1,513	12,008
Zinc-lead pigments, short tons			(a)	(a)			(a)	(a)
Mineral waters, gallons sold	2,762,319	349,255			2,873,288	298,473		
Pyrite.....long tons	162,478	621,219			148,259	587,041		
Rutile.....short tons			275	27,500			305	49,000
Salt.....barrels			(a)	(a)			(a)	(a)
Sand and gravel, short tons	689,266	291,773			787,009	239,591		
Silver, fine ounces (troy)			982	604			960	580
Slate				195,392				175,830
Stone		(e)		e 877,746		(e)		e 1,063,782
Talc and soapstone, short tons	(e)	(e)	e 25,313	e 576,473	(e)	(e)	e 26,487	e 615,558
Zinc.....short tons			249	34,309			2,719	304,528
Miscellaneous		2,676		1,190,511		(e)		e 1,274,837
Total value, eliminating duplications	$14,995,842				$17,178,580			

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of pottery, value for which is included under "Miscellaneous."
d Manganese ore alone.
e Raw product included in derived product.

WASHINGTON.

Washington is the only State on the Pacific coast in which coal mining is an industry of any importance, and it is the only State included in the Pacific coast division in which coal is the chief mineral product of value. The value of the coal product of Washington has for several years exceeded 50 per cent of the total value of the mineral production of the State. In 1912, out of a total production valued at $15,347,313, the output of the coal mines represented $8,042,871, the quantity of coal mined amounting to 3,360,932 short tons. In 1913 the production of coal amounted to 3,877,891 short tons, valued at $9,243,137, and the total value of the mineral production of the State was $17,579,743. The year 1913 was the first one since 1910 in which an increase in the production of coal was shown; and, notwithstanding a gain of over 500,000 tons in output over 1912, the record for 1913 was still short of the maximum output of 1910. The decrease in production in 1911 and 1912 was due to the competition with fuel oil from California. The advantages of fuel oil are so marked in labor economy and particularly as a sparkless fuel in the heavily forested State of Washington that transportation companies having their own coal mines are using oil in their locomotives from Portland and Puget Sound through and beyond the forested areas of the coast and Cascade region. The increased production in 1913 does not indicate any lessening of the consumption of fuel oil, and was due entirely to the labor troubles in the coal mine of Vancouver Island, British Columbia, which augmented the demand for Washington coal. With the exception of a small area, known as the Roslyn field, in Kittitas County, on the eastern edge of the Cascade Mountains, the principal coal fields of Washington are in close proximity to Puget Sound, the cities of Seattle and Tacoma obtaining their fuel supply from mines less than 50 miles distant. The principal producing counties are King, Kittitas, and Pierce, with smaller quantities from Lewis, Thurston, and Whatcom counties. Some of the Pierce County coal makes a fair grade of coke, and considerable quantities of coke are made at ovens located at Carbonado, Fairfax, and Wilkeson. The coal used for coke making is washed, and most of the coke is sold to the smelter at Tacoma, smaller quantities going to Portland and Seattle for foundry use. The coal of Pierce County is the only coking coal on the Pacific coast. The quantity of coke made in 1913 was 76,221 short tons, valued at $432,770, against 49,260 tons, valued at $279,105 in 1912.

Up to 1913 the chief mineral industry of Washington, next to coal, was clay working, but in 1913 the value of the clay products gave way to that of cement, which showed a decided increase in production, from 1,438,137 barrels, valued at $2,012,785, in 1912, to 2,023,172 barrels, valued at $2,853,260, in 1913. There are six cement-making establishments in the State, one each at Asotin, Bellingham, Metaline Falls, and Trent, and two at Concrete.

The value of the clay products, exclusive of pottery, was approximately the same in each of the last two years, being $2,388,870 in 1912 and $2,390,226 in 1913. The principal products are vitrified brick, common brick, sewer pipe, architectural terra cotta, and fireproofing, in the order named. King County, adjacent to the mar-

kets of Seattle and Tacoma, is the principal producing county, with an output valued at about 55 per cent of the State's total. Other important counties are Spokane and Stevens. Brick are made from local clay deposits at the principal towns in more than one-half of the counties of the State. Fire clay is mined and used in Spokane County; occurrences have also been noted in Cowlitz and Stevens counties. Pottery clay is dug and utilized in King County, and occurrences have also been noted in Cowlitz and Whitman counties. Kaolin is reported in Pierce County, but is not mined. As there are less than three producers of pottery in Washington the production is included in the miscellaneous products.

The principal stone products of Washington are basalt and sandstone, and the quarry products rank fourth in the value of the State's mineral products. The total value of the quarry products in 1913 was $1,399,475, of which $632,915 represented the value of the basalt, and $560,468 the value of the sandstone. Basalt is the most abundant surface rock in the State, and is quarried in Clarke, King, Lewis, Spokane, Walla Walla, and Yakima counties. Granite is quarried in Spokane and Whitman counties and is reported in unlimited quantities in Snohomish County. The principal use of the basalt is for jetty work and for riprap. It is also used for road making and concrete. The principal use for sandstone, which comes chiefly from Thurston County, with smaller quantities from King, Kitsap, Pierce, San Juan, and Whatcom counties, is about equally divided between building and riprapping. Limestone, produced principally in San Juan and Snohomish counties, is used chiefly for flux and lime burning. Cement material is quarried also in Ferry, King, Chelan, Okanogan, San Juan, Skagit, Stevens, and Whatcom counties.

The gold production of Washington increased from 32,942 fine ounces, valued at $680,964, in 1912 to 33,682 fine ounces, valued at $696,275, while the production of silver decreased from 413,538 fine ounces, valued at $254,326, in 1912 to 331,239 fine ounces, valued at $200,068, in 1913.

The digging of gravel, chiefly for concrete and railroad ballast, and of sand, principally for building purposes, is an industry of some importance in the State. The quantity of sand and gravel produced increased from 1,020,841 short tons, valued at $345,289, in 1912 to 1,301,771 tons, valued at $385,886, in 1913.

The other commercial mineral products of Washington are copper, occasional gems, diatomaceous (infusorial) earth, lead, lime, mineral paints, mineral waters, sand-lime brick, tungsten ores, and zinc, though none of the last was produced in either 1912 or 1913. The total value of the mineral products of the State increased from $15,347,313 in 1912 to $17,579,743 in 1913, distributed by substances as shown in the following table:

Mineral production of Washington in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel, short tons			[a] [b]	[a] [b]			[a] [b]	[a] [b]
Cement, barrels			1,438,137	$2,012,785			2,023,172	$2,853,260
Clay products, short tons	1,570	[b]$5,000		[c] 2,388,870	2,028	[b]$8,837		[c]2,390,226
Coal, short tons	3,360,932	8,042,871			3,877,891	9,243,137		
Coke, do			49,260	[b]279,105			76,221	[b]432,770
Copper, pounds			1,086,010	179,192			954,081	147,883
Gems and precious stones				235				500
Gold, fine ounces (troy)			32,942	680,964			33,682	696,275
Infusorial earth								[a]
Lead, short tons			64	5,732			101	8,909
Lime, do			29,078	206,032			28,070	178,945
Mineral paints, natural pigments, short tons			[a]	[a]			[a]	[a]
Mineral waters, gallons sold	156,171	17,542			150,498	18,834		
Sand and gravel, short tons	1,020,841	345,289			1,301,771	385,886		
Sand-lime brick				[a]				[a]
Silver, fine ounces (troy)			413,538	254,326			331,239	200,068
Stone		[d]		[d]1,174,047		[d]		[d]1,399,475
Tungsten ore (60 per cent concentrates), short tons							[a]	[a]
Miscellaneous				99,428				92,345
Total value, eliminating duplications				$15,347,313				$17,579,743

[a] Value included under "Miscellaneous."
[b] Value not included in total value.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Stone sold rough included in derived product.

WEST VIRGINIA.

West Virginia, which ranks second among the States in the value of its mineral products, owes its position in this regard to its resources in and its production of solid, liquid, and gaseous fuels. There are comparatively few mineral products in the State, 17 substances, including coke and pig iron, comprising the list. In the production of coal West Virginia ranks second in the quantity and value. It ranks fourth in the production of petroleum and stands well at the head of all the States in the production of natural gas. These three fuels represent more than 90 per cent of the total mineral production of the State as expressed in values, coal alone constituting nearly 50 per cent, natural gas nearly 25 per cent, and petroleum 20 per cent. Although West Virginia stands second in the total value of its mineral production and although more than 90 per cent of that total is represented by its fuels, the State ranks comparatively low in the value of its manufactures. Probably not more than 20 per cent, certainly not more than 25 per cent, of the output of these fuels is consumed for useful purposes within the State. More than half of the natural gas produced is piped for consumption into

Pennsylvania and Ohio. The principal consumption of coal in West Virginia is by the locomotives in the transportation of the product to consumers in other States. Little of the petroleum produced in West Virginia is refined within the State. What is true of the coal is also true of the coke made from West Virginia coal. Until 1912 the State ranked either second or third in the manufacture of coke, with Alabama as its only close rival. In 1912 West Virginia dropped to fourth place in the manufacture of coke, not because of a decrease in production but because of the rise of Indiana as a manufacturer of this product; and not only has Indiana taken precedence of West Virginia in the quantity and value of its coke, but it draws its chief supply of coking coal from West Virginia mines. In fact, more coke has been made in other States from West Virginia coal in the last few years than has been made in that State itself. In 1913 the quantity of coal made into coke in West Virginia was 4,034,251 short tons; whereas 7,546,674 tons, or nearly twice as much as that consumed in West Virginia, was made into coke at ovens outside of the State. The maximum production of coke in West Virginia was in 1907, when the output amounted to 4,112,896 short tons. In 1913 the production of coke in the State was 2,472,752 short tons. It is doubtful if the tonnage attained in 1907 will be reached again at an early date, as the tendency is toward the manufacture of coke in by-product ovens at points of consumption rather than at beehive ovens in the vicinity of the mines, and as there are few points of consumption in West Virginia the quantity of its coal shipped to distant localities for coke making will increase and the coke made in the State will fall behind. The ovens which draw their supply from West Virginia are located at Gary and Indianapolis, in Indiana; Chicago and Joliet, in Illinois; Detroit and Wyandotte, in Michigan; Hamilton and Cleveland, in Ohio; and Low Moor and Covington, in Virginia.

Coal, the principal mineral product of West Virginia, contributes almost exactly 50 per cent of the total value of the mineral production of the State. In the 31 years during which the volumes, Mineral Resources of the United States, have been published the coal production of West Virginia has increased more than that many times. In 1882, the first year covered by this series of reports, the coal production of West Virginia was placed at 2,240,000 short tons. The maximum production, attained in 1913, was 71,308,982 short tons. This was an increase over 1912, the year of previous maximum production, of 4,522,295 tons. The value increased somewhat more in proportion, from $62,792,234 in 1912 to $71,872,165 in 1913; and for the third time in more than 20 years the average value per ton for West Virginia coal exceeded $1, the other two exceptions being in 1902 and 1903, in which years, because of the scarcity of coal caused by the strike in the anthracite region of Pennsylvania, prices were abnormally advanced. Coal is produced in 34 out of the 55 counties in the State, the most important in production being Fayette, Kanawha, Logan, McDowell, Mercer, Mingo, and Raleigh in the southwestern part of the State, and Barbour, Harrison, Marion, Preston, Taylor, and Tucker in the northern part of the State.

Second in importance among the State's mineral industries, value of output considered, is natural gas, which in 1913 was valued at $34,164,850, against $33,324,475 in 1912. Third in importance is petroleum, the output of which in quantity decreased from 12,128,962

barrels in 1912 to 11,567,299 barrels in 1913, but on account of the sharp advance in prices in the latter year the total value increased from $19,927,721 to $28,828,814. The principal petroleum-producing counties are Ritchie, Pleasants, Tyler, Wetzel, Harrison, Kanawha, and Lincoln, and it is produced in smaller quantities in 16 other counties. The promised increase in the production in the Falling Rock Creek pool and the Big Sandy district, to which reference was made in the report for 1912, was not realized in 1913. The three fuels—coal, petroleum, and natural gas—produced in West Virginia in 1913 had a total value of $134,865,829, or nearly 94 per cent of the total value of the mineral products of the State.

Next to the fuels the clay products of West Virginia are the most important of its mineral industries, and of the total value of the clay products the potteries contributed over 60 per cent. In 1913 the total value of the clay products of West Virginia was $5,208,270, of which the pottery products contributed $3,424,887. In 1912 the total value of the clay products was $4,775,874, of which the potteries contributed $3,365,166. The development of the pottery industry, which is centered in Hancock County, has had much to do with the increase in the value of the clay products in the last five years. West Virginia is third among the States in the value of its pottery products, being exceeded only by Ohio and New Jersey. The other clay products of the State are vitrified brick, which is the most important, representing nearly 15 per cent of the total, followed by common brick and fire brick. The first trial in the United States of vitrified brick as a paving material was made in Charleston, W. Va., and the manufacture of the product is of considerable importance in the State. Hancock is at present the principal county in the manufacture of vitrified brick. Ordinary clay for the manufacture of common brick is dug and used in about half of the counties in the State. Fire clay occurs in a number of the counties and has been worked in several of them. Flint and plastic clay are mined in Marion County, and clay suitable for the manufacture of stoneware has been dug in Harrison, Jackson, Monongalia, and Wood counties.

The principal quarry product of West Virginia is limestone, the quarries of which, exclusive of those which produced stone for lime burning, contributed nearly 90 per cent of the total value of the stone production. The northern part of the Shenandoah Valley is particularly rich in limestone suitable for iron-furnace flux, and approximately 70 per cent of the limestone produced in the State is for this purpose. The principal quarries for flux limestone are located in Berkeley County. Limestone for building purposes is quarried in Greenbrier, Jefferson, and Preston counties, and for crushed stone in Greenbrier, Jefferson, Preston, Mineral, and Monroe counties. Sandstone, which represents about 13 per cent of the total value of the quarry products, is largely from Preston County, though it is also quarried in many other parts of the State. The total value of the stone produced in West Virginia increased from $1,164,877 in 1912, to $1,193,323 in 1913. The lime production increased only slightly from 232,584 short tons, valued at $734,644 in 1912, to 232,683 tons, valued at $789,901 in 1913.

Sand and gravel production increased from 849,864 short tons, valued at $530,025, in 1912, to 1,026,960 tons, valued at $939,933, in 1913. More than 70 per cent of this value is in the output of glass

sand, a product in which West Virginia ranks second and next to Pennsylvania. The State furnishes a large quantity of this material from the region of Berkeley Springs, Morgan County; Deckers Creek, Monongalia County; Craddock, Upshur County; and near Corinth, Preston County.

Among the less important mineral products of West Virginia are aluminum, bromine, calcium chloride, grindstones, iron ore, mineral waters, and salt. The production of cement is an industry of some importance, but because of there being less than three producers in the State the statistics of production are not published. The total value of the mineral products increased from $123,847,812 in 1912 to $143,640,633 in 1913. The total value of the mineral products of West Virginia in 1913 showed an increase of more than 40 per cent over 1911 only two years before. The distribution of the production by substances for 1912 and 1913 is shown in the following table:

Mineral production of West Virginia in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Aluminum..pounds..	.....	.....	(a) (b)	(a) (b)	.....	.....	.....	.....
Bromine.....do..	.....	.....	52,827	$11,687	.....	.....	(a)	(a)
Calcium chloride, short tons.....	.....	.....	2,930	17,817	.....	.....	(a)	(a)
Cement.....barrels..	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Clay products, short tons.....	82,768	b $58,776	.....	4,775,874	77,171	b $65,239	.....	$5,208,270
Coal.....short tons..	66,786,687	62,792,234	.....	.....	71,308,982	71,872,165	.....	.....
Coke.....do..	.....	.....	2,465,986	b4,692,393	.....	.....	2,472,752	b5,504,416
Grindstones.....	.....	.....	.....	(a)	.....	.....	.....	(a)
Iron ore...long tons..	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Iron, pig.....do..	.....	.....	(a) (b)	(a) (b) 4	.....	.....	(a) (b)	(a) (b)
Lime....short tons..	.....	.....	232,584	734,64	.....	.....	232,683	789,901
Mineral waters, gallons sold.....	309,245	60,445	.....	.....	316,749	52,259	.....	.....
Natural gas.....	.....	33,324,475	.....	.....	.....	34,164,850	.....	.....
Petroleum..barrels..	12,128,962	19,927,721	.....	.....	11,567,299	28,828,814	.....	.....
Salt.....do....	.....	.....	139,121	66,023	.....	.....	113,921	63,803
Sand and gravel, short tons.....	849,864	530,025	.....	.....	1,026,960	939,933	.....	.....
Stone.....	.....	(c)	.....	c1,164,877	.....	(c)	.....	c1,193,323
Miscellaneous.....	.....	(c)	.....	c4,464,182	.....	(c)	.....	c4,202,852
Total value, eliminating duplications.	$123,847,812				$143,640,633			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included in derived product.

WISCONSIN.

The chief mineral product of value in Wisconsin is zinc, which represents nearly 25 per cent of the total value of the mineral products of the State. Wisconsin leads all the States in the value of mineral waters produced, this value being, however, only about one-fourth that of the zinc produced.

In the production of primary spelter Wisconsin ranks fourth among the States, but when the zinc content of the ores mined is considered, New Jersey takes precedence over Wisconsin and the latter drops

to fifth in rank. Nearly all of the zinc produced in New Jersey, however, is recovered as zinc oxide and not as spelter. The zinc content of the ore mined in Wisconsin decreased from 33,050 short tons, valued at $4,560,900, in 1912, to 30,110 short tons, valued at $3,372,320, in 1913. The zinc mines are located in Grant, Iowa, and Lafayette counties.

In 1912 the second in importance among the mineral products of Wisconsin was iron ore. As a producer of iron ore Wisconsin is included in the Lake Superior district, portions of the Menominee and Gogebic ranges extending from Michigan into Wisconsin. Wisconsin, however, ranks as a rather poor third to the other two Lake Superior States, Minnesota and Michigan, in the quantity of iron ore produced, only about 2 per cent of the Lake Superior product being credited to Wisconsin. The marketed production of iron ore in the State in 1913 was 896,243 long tons, valued at $2,149,397, a decrease in quantity from 1,152,250 tons in 1912 and in value from $2,731,574. This decrease in iron ore production in 1913 placed the value of iron mining a little below that of the quarry products. The value of the stone produced in Wisconsin in 1913 (exclusive of the limestone used for the manufacture of lime) was $2,157,980, about $8,500 more than the value of the iron ore. The principal quarry products are limestone and granite, the former having a total value in 1913 of $1,017,135, and the latter, $927,616. Limestone is quarried in Brown, Buffalo, Calumet, Columbia, Crawford, Dane, Dodge, Door, Fond du Lac, Grant, Green, Iowa, Kewaunee, La Crosse, Lafayette, Manitowoc, Milwaukee, Monroe, Outagamie, Ozaukee, Pierce, Racine, Rock, Sauk, Sheboygan, Trempealeau, Vernon, Walworth, Waukesha, Waupaca, and Winnebago counties. Granite is quarried chiefly in Douglas, Green Lake, Marathon, Marquette, Marinette, Oconto, Waupaca, and Waushara counties. Over two-thirds of the limestone produced in the State is crushed for use in road making, as railroad ballast, and for concrete. Nearly half of the value of the granite produced in Wisconsin is used for the manufacture of paving blocks—the only State in which the manufacture of paving blocks is the most important branch of the granite-quarrying industry. Next to the paving blocks the principal use for the granite quarried in Wisconsin is in connection with monumental work, relatively small quantities being reported as used for building and as crushed stone. The lime production showed a decrease from 263,052 short tons in 1912 to 243,006 tons in 1913, but showed an increase in value from $825,551 to $1,005,496.

The only other product which exceeded $1,000,000 in annual value is that of the clay pits. The value of the clay products decreased from $1,044,486 in 1912 to $1,020,028 in 1913. The chief product is common brick, and the leading clay-working county is Milwaukee, the city of the same name furnishing the chief market for the output. Common brick, however, are made in nearly every large town in the State. A small quantity of kaolin, which is produced in St. Croix County, is washed and sold to paper manufacturers. Other kaolin occurrences are noted in Barron, Jackson, and Wood counties. Terra cotta is made in Rock County from a mixture of white-burning and red-burning clays. The other commercial mineral products of the State are graphite, lead, manganiferous ore, mineral paints, pyrite (for sulphuric-acid making), sand and gravel, sand-lime brick, and

silica. The total value of the mineral products of Wisconsin decreased from $14,192,287 in 1912 to $12,452,480 in 1913, the distribution by substances being as shown in the following table:

Mineral production of Wisconsin in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Briquets, fuel, short tons	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Clay products, short tons	836	b $1,172	.....	$1,044,486	742	b $1,286	.....	$1,020,728
Coke, short tons	.....	.....	(a) (b)	(a) (b)	.....	.....	(a) (b)	(a) (b)
Graphite amorphous, short tons	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Iron ore, long tons	1,152,250	2,731,574	.....	.....	896,243	2,149,397	.....	.....
Iron, pig, do	.....	.....	270,981	b3,883,125	.....	.....	292,793	b4,430,117
Lead, short tons	.....	.....	2,581	232,290	.....	.....	1,866	164,208
Lime, do	.....	.....	263,052	825,551	.....	.....	243,006	1,005,496
Manganiferous ore, long tons	c 284,591	(c)	.....	.....	c 209,075	(c)	.....	.....
Mineral paints:								
Natural pigments, short tons	.....	.....	2,106	9,953	.....	.....	2,144	11,584
Zinc-lead pigments, short tons	.....	.....	(a)	(a)	.....	.....	(a)	(a)
Mineral waters, gallons sold	6,045,719	869,495	.....	.....	6,326,533	872,518	.....	.....
Pyrite, long tons	17,898	70,518	.....	.....	25,328	94,727	.....	.....
Sand and gravel, short tons	3,051,819	664,327	.....	.....	4,044,754	772,125	.....	.....
Sand-lime brick	.....	.....	.....	70,795	.....	.....	.....	77,564
Silica, short tons	(a)	(a)	.....	.....	(a)	(a)	.....	.....
Stone	.....	(d)	.....	d2,211,847	.....	(d)	.....	d2,157,980
Zinc, short tons	.....	.....	33,050	4,560,900	.....	.....	30,110	3,372,320
Miscellaneous	.....	34,368	.....	3,569,385	.....	60,943	.....	3,750,390
Total value, eliminating duplications	$14,192,287				$12,452,480			

a Value included under "Miscellaneous."
b Value not included in total value.
c Tonnage and value included in iron ore.
d Stone sold rough included in derived product.

WYOMING.

Wyoming, like New Mexico, is one of the Rocky Mountain States which lays little claim to distinction as a metal miner, and depends principally upon its coal mines for recognition as a mining State. The value of the coal production in Wyoming represents nearly 90 per cent of the total mineral production. The principal coal-mining operations are in Sweetwater, Uinta, Sheridan, Fremont, Carbon, Bighorn, Lincoln, and Western counties, with smaller quantities from Converse, Crook, Johnson, and Park counties. The total value of all the mineral products in 1913 was $13,682,091, of which the coal mines contributed $11,510,045. In 1912, out of a total production of $13,374,088, the coal production was valued at $11,648,088. The quantity of coal produced was 7,393,066 short tons in 1913 and 7,368,124 tons in 1912.

The only other mineral product of any importance in 1913 was petroleum, which amounted to 2,406,522 barrels, valued at $1,187,232, against 1,572,306 barrels, valued at $798,470, in 1912. Outside of

the coal and petroleum the value of the mineral products of the State combined was a little less than $1,000,000. The substances which contributed to this are clay products, copper, gems, gold, gypsum, iron ore, lime, mineral waters, natural gas, phosphate rock, sand and gravel, silver, stone, and sulphur. As in Idaho, the development of the extensive phosphate deposits in the southwestern part of Wyoming gives promise of the establishment of an important industry at some time in the future. The following table gives the quantity and value of the mineral production of Wyoming in 1912 and 1913:

Mineral production of Wyoming in 1912 and 1913.

Product.	1912				1913			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	(a)	(a)						
Clay products.....do....	(a) (b)	(a) (b)		$45,103	(a) (b)	(a) (b)		$61,678
Coal.....do....	7,368,124	$11,648,088			7,393,066	$11,510,045		
opper.....pounds..			27,570	4,549			385,239	59,712
Gems and precious stones..				50				300
Gold..fine ounces (troy)..			1,076	22,235			1,170	24,184
Gypsum.....short tons..	36,581			89,992	30,632			74,862
Iron ore.....long tons..	(a)	(a)			(a)	(a)		
Lime.....short tons..			(a)	(a)			13	168
Mineral waters, gallons sold.....	(a)	(a)			16,200	3,610		
Natural gas.....		(a)				(a)		
Petroleum.....barrels..	1,572,306	798,470			2,406,522	1,187,232		
Phosphate rock, long tons.....	(a)	(a)			(a)	(a)		
Sand and gravel, short tons.....	639,031	56,753			771,139	63,577		
Silver..fine ounces (troy)..			265	163			957	578
Stone.....		(c)		c68,479		(c)		c109,784
Sulphur.....long tons..	(a)	(a)			(a)	(a)		
Miscellaneous.....		(c)		c642,101		587,969		
Total value, eliminating duplications.....	$13,374,088				$13,682,091			

a Value included under "Miscellaneous."
b Value not included in total value.
c Raw product included under derived product.

SUMMARY OF THE MINERAL PRODUCTION OF THE UNITED STATES IN 1913.

Compiled by W. T. Thom.

GENERAL REMARKS.

The different units of measurement employed in the mineral industry make it impossible to combine and compare the output of the several minerals except in value.

In 1905, for the first time, the total value of the domestic mineral production exceeded $1,500,000,000; and in 1907, and again in 1912 and 1913, it exceeded $2,000,000,000.

In 1908 the results of the financial depression of the latter part of 1907 became apparent in the decrease in value of the mineral output, which declined for the year to about $1,595,000,000 from over $2,000,000,000 in 1907. In 1909 the general recovery in business carried the value of the domestic mineral production up to $1,887,582,445. In 1910 the continued favorable business conditions raised the value to $1,992,431,412, almost to the high level of 1907. In 1911 there was a sharp decline in pig iron that brought the total value for the year down to $1,927,532,128. In 1912 the general swing of business carried the value of mineral production up to $2,243,972,481, a gain of $316,440,353 over the production of 1911. In 1913 the mineral production attained its highest value thus far recorded, the total being $2,445,805,017, a gain of $201,832,536, or 9 per cent, over the production of 1912.

As heretofore, iron and coal are the most valuable of our mineral products. The value of iron (pig iron being the basis of valuation) in 1913 was $458,342,345; the value of coal was $760,488,785. The fuels—coal, natural gas, and petroleum—increased from $944,383,275 in 1912 to $1,085,456,850 in 1913, a gain of $141,073,575. Anthracite coal showed an increase in value of $17,558,501 from $177,622,626 in 1912 to $195,181,127 in 1913. The increase in value of the bituminous coal output from $517,983,445 in 1912 to $565,307,658 in 1913 was $47,324,213.

The value of metals produced increased $15,882,071, or 1.83 per cent, from $867,103,085 in 1912 to $882,980,156 in 1913. The value of the nonmetals increased $185,955,465, or 13.51 per cent, from $1,376,369,396 in 1912 to $1,562,324,861 in 1913. The unspecified products, including bismuth, cadmium, lithium, marl, selenium, and other minerals, valued, as in 1912, at $500,000, bring the total value of the mineral production for 1913 up to $2,445,805,017.

The total values for 1912 and 1913 exceeded the hitherto unsurpassed total value for 1907 by about $171,000,000 and $373,000,000,

respectively. Judged by the record of mineral production, therefore, 1912 and 1913 were years of more general domestic welfare than 1907.

The imports cited in this summary and in the volume are "imports for consumption," which may or may not be identical with the "total imports" for the calendar year. Merchandise brought into the country late in December, for example, may be entered for consumption or it may be put into a warehouse and not be withdrawn for consumption until some months later. It will then be credited for consumption to the year of its withdrawal from the warehouse.

METALS AND ORES.

Metals and metallic ores.—The report on metals and metallic ores was published for the first time in this series in the volume for 1909. The output of metals in the United States in 1913 from domestic ores was valued at $855,351,064, from foreign sources at $161,256,794, the total value being $1,016,607,858; in 1912, from domestic ores, $834,520,702; from foreign sources, $161,277,916; total value, $995,798,618. The output of crude metallic ores of all kinds from domestic mines amounted in 1912 to 130,728,622 short tons and in 1913 to 134,215,858 short tons.

Iron and steel.—Twenty States produced and marketed pig iron (exclusive of ferro-alloys) in 1913, as in 1912. The total marketed production of pig iron in 1913 was 30,388,935 long tons, valued at $458,342,345, compared with 30,180,969 long tons, valued at $420,563,388, in 1912, and 23,257,288 long tons, valued at $327,334,624, in 1911. The average annual output and value for the five years from 1905 to 1909, inclusive, was 23,162,484 long tons, valued at $418,321,000. The marketed production in 1913 showed an increase in quantity of 207,966 long tons, or 0.69 per cent, over the production of 1912, and an increase in value from $420,563,388 to $458,342,345, amounting to $37,778,957, or 8.98 per cent. The average price per long ton of pig iron rose from $19.98 in 1906 to $20.56 in 1907, fell to $15.96 in 1908, rose to $16.25 in 1909, fell to $15.45 in 1910, to $14.07 in 1911, to $13.93 in 1912, and rose to $15.08 in 1913.

Iron ore.—The marketed production of iron ore in 1913 amounted to 59,643,098 long tons, valued at the mines at $130,905,558, as compared with 57,017,614 long tons, valued at $107,050,153, in 1912, and 41,092,447 long tons, valued at $86,716,575, in 1911. As in the 14 preceding years, the production of iron ore in the United States in 1913 was not equaled by that of any other country. The general imports of iron ore were valued at $8,336,819 in 1913, $6,499,690 in 1912, $5,412,636 in 1911, and $7,832,225 in 1910, and $3,154,081 was the average annual value for the five years from 1905 to 1909. The exports were valued at $3,513,419 in 1913, $3,537,289 in 1912, $2,653,448 in 1911, $2,474,164 in 1910, and $1,365,325 in 1909.

Ferro-alloys.—In the iron report for 1911 the United States Geological Survey undertook for the first time to present the statistics of production of ferro-alloys separately from those of pig iron, with which they had been included.

As reported, the marketed production of ferro-alloys in 1913 was 296,207 long tons, valued at $13,015,362, compared with 328,685 long tons, valued at $12,223,776, in 1912, and 253,375 long tons,

valued at $8,377,832, in 1911. Part of the output is derived from foreign ores. The quantity reported does not represent the total production of the United States, as considerable quantities of electrically produced ferro-alloys were not reported to the Survey.

The Bureau of Foreign and Domestic Commerce reports the following values of imports for consumption of ferro-alloys in 1912 and 1913: Chrome and ferrochrome, $77,587 in 1912 and $51,415 in 1913; ferrophosphorus, $4,465 in 1912 (none imported in 1913); ferrosilicon, $446,456 and $449,871; ferromanganese, $3,906,920 and $5,682,915; molybdenum and ferromolybdenum, $4,670 and $15,939; spiegeleisen, $28,094 and $2,173; titanium and ferrotitanium, $7,631 and $7,198; tungsten and ferrotungsten, $323,872 and $835,212—a total of $4,799,695 in 1912 and $7,044,723 in 1913.

Manganese ore.—The marketed production of manganese ore in 1913 was 4,078 long tons, valued at $40,480, compared with 1,664 long tons, valued at $15,723, in 1912; 2,457 long tons, valued at $24,586, in 1911; 2,258 long tons, valued at $22,892, in 1910; 1,544 long tons, valued at $19,675, in 1909; and 5,187 long tons, valued at $55,992, the average annual production for the five preceding years. The average price per ton was $10.01 in 1911, $9.45 in 1912, and $10 in 1913. Manganiferous ore, carrying from 20 to 40 per cent of manganese, was marketed in 1913 to the extent of 59,403 long tons, valued at $25,124, against 51,517 long tons, valued at $19,942, in 1912, and 44,437 long tons, valued at $114,918, in 1911. The imports for consumption of manganese ore in 1913 were 345,090 long tons, valued at $2,029,680, against 300,661 long tons, valued at $1,769,184, in 1912, and 176,852 long tons, valued at $1,186,791, in 1911.

Gold.—The production of gold was 4,299,784 fine ounces, valued at $88,884,400, in 1913, compared with 4,520,717 fine ounces, valued at $93,451,500, in 1912; 4,687,053 fine ounces, valued at $96,890,000, in 1911; 4,657,018 fine ounces, valued at $96,269,100, in 1910; and 4,520,389 ounces, valued at $92,804,720, the average annual production for the preceding five-year period. The decrease in 1913 was 220,933 fine ounces, valued at $4,567,100.

Silver.—The production of silver in 1913 was 66,801,500 fine ounces, valued at $40,348,100, against 63,766,800 fine ounces, valued at $39,197,500, in 1912; 60,399,400 fine ounces, valued at $32,615,700, in 1911; 57,137,900 fine ounces, valued at $30,854,500, in 1910; and 55,259,300 fine ounces, valued at $33,256,780, the average yearly production for the five years from 1905 to 1909, inclusive. The increase in 1913 was 3,034,700 fine ounces, valued at $1,150,600.

Copper.—The production of copper in 1913 was 1,224,484,098 pounds, valued at $189,795,035, against 1,243,268,720 pounds, valued at $205,139,338, in 1912; 1,097,232,749 pounds, valued at $137,154,092, in 1911; 1,080,159,509 pounds, valued at $137,180,257, in 1910; and 942,221,757 pounds, valued at $151,131,959, the average production for the five-year period ending with 1909. The decrease in 1913 was 18,784,622 pounds, valued at $15,344,303. The general imports in 1913 were valued at $57,901,901, against $57,012,057 in 1912, $38,525,939 in 1911, and $40,849,239 in 1910. The exports in 1913 were valued at $147,883,114 against $129,973,387 in 1912, $105,679,926 in 1911, and $96,554,432 in 1910.

Lead.—The production of lead in 1913 was 436,430 short tons, valued at $38,405,840, compared with 415,395 short tons, valued at $37,385,550, in 1912; 405,863 short tons, valued at $36,527,670, in 1911; and 389,211 short tons, valued at $34,250,568, in 1910. The imports for consumption of lead were valued at $572,980 in 1913, against $605,551 in 1912, $631,654 in 1911, and $755,092 in 1910. The exports of manufactures of lead were valued at $651,459 in 1912, $680,419 in 1911, and $614,158 in 1910. The imports of type metal were valued at $20,098 in 1913, $18,668 in 1912, $310,658 in 1911, and $485,493 in 1910.

Antimonial lead.—The production of antimonial lead in 1913 was 16,665 short tons, valued at $1,675,179, against 13,552 short tons, valued at $1,311,348, in 1912; 14,078 short tons, valued at $1,380,556, in 1911; and 14,069 short tons, valued at $1,338,090, in 1910.

Zinc.—The production of zinc in 1913 was 337,252 short tons, valued at $37,772,224, compared with 323,907 short tons, valued at $44,699,166, in 1912; 271,621 short tons, valued at $30,964,794, in 1911; 252,479 short tons, valued at $27,267,732, in 1910; 230,225 short tons, valued at $24,864,300, in 1909; and 200,948 short tons, valued at $22,283,873, the average annual production for the five-year period ending with 1908. The imports for consumption of zinc, including zinc dust and zinc ores, were valued at $1,068,058 in 1913, $1,952,011 in 1912, $408,299 in 1911, and $990,065 in 1910; the exports of domestic zinc ore, zinc dust, and manufactures of zinc were valued at $1,735,099 in 1913, $1,846,301 in 1912, $1,935,677 in 1911, and $1,558,271 in 1910.

Bauxite.—In 1913 the production of bauxite was 210, 241 long tons, valued at $997,698, compared with 159,865 long tons, valued at $768,932, in 1912; 155,618 long tons, valued at $750,649, in 1911; 148,932 long tons, valued at $716,258, in 1910; and 83,717 long tons, valued at $421,955, the average annual production for the five-year period from 1905 to 1909. The imports for consumption in 1913 were 21,456 long tons, valued at $85,746, against 26,214 long tons, valued at $95,431, in 1912; 43,222 long tons, valued at $164,301, in 1911; and 15,669 long tons, valued at $65,743, in 1910.

Aluminum.—The consumption of aluminum during 1913 was 72,379,000 pounds, valued at $13,845,000, against 65,607,000 pounds, valued at $11,907,000, in 1912; 46,125,000 pounds, valued at $8,084,000, in 1911; 47,734,000 pounds, valued at $8,955,700, in 1910; and 17,766,000 pounds, valued at $4,288,600, the average annual consumption for the period from 1905 to 1909. The imports for consumption of aluminum salts were valued at $66,549 in 1913 and $84,606 in 1912. The exports of manufactures of aluminum were valued at $966,094 in 1913, $1,347,621 in 1912, $1,158,603 in 1911, $949,215 in 1910, $567,375 in 1909, and $330,092 in 1908.

Quicksilver.—The production of quicksilver in 1913 amounted to 20,213 flasks, valued at $813,171, against 25,064 flasks, valued at $1,053,941, in 1912; 21,256 flasks, valued at $977,989, in 1911; 20,601 flasks, valued at $958,153, in 1910; and 21,075 flasks, valued at $957,859, in 1909. California reported 15,591 flasks in 1913, against 20,524 flasks in 1912, 18,860 flasks in 1911, 17,211 flasks in 1910, and 16,078 flasks in 1909. Nevada reported 1,645 flasks in 1913, and Texas and Nevada reported 4,540 flasks in 1912, 2,396 flasks in 1911, and 3,390 flasks in 1910. The production of Texas

and Arizona was combined in 1913. No output was reported from Arizona, Oregon, Utah, or Washington in 1912. The imports for consumption were valued at $75,361 in 1913, $39,920 in 1912, and $251,386 in 1911. The exports were valued at $43,574 in 1913, $13,360 in 1912, $13,995 in 1911, $91,077 in 1910, $266,243 in 1909, and $124,960 in 1908.

Chromic iron ore.—The production of chromic iron ore in 1913 was 255 long tons, valued at $2,854, compared with 201 long tons, valued at $2,753, in 1912; 120 long tons, valued at $1,629, in 1911; 205 long tons, valued at $2,729, in 1910; and 598 long tons, valued at $8,300, in 1909. The imports for consumption of chrome ore in 1913 were 65,180 long tons, valued at $622,821; 53,929 long tons, valued at $499,818, in 1912; 37,540 long tons, valued at $407,958, in 1911; 38,579 long tons, valued at $415,768, in 1910; and 39,624 long tons, valued at $460,758, in 1909. The imports of chrome salts were valued at $2,919 in 1913 and $4,461 in 1912.

Molybdenum minerals.—No production of molybdenum has been reported since 1907. There was a small commercial production in 1907, as in 1906 and 1905. Imports were valued at $15,939 in 1913, $4,670 in 1912, $11,409 in 1911, and $14,402 in 1910.

Nickel.—The production of nickel in 1908, 1909, and 1910 was included under unspecified products. There was no production of nickel ore reported in 1911, but nickel salts and metallic nickel equivalent to 445 short tons of metallic nickel, valued at about $127,000, were saved as by-products, largely from copper refineries, and about 328 short tons were saved in 1912; there was also a saving as by-products in 1913. The imports for consumption of nickel in 1913 were valued at $6,600,755, against $5,758,967 in 1912, $4,050,030 in 1911, $4,227,838 in 1910, and $3,036,273 in 1909. The exports were valued at $9,686,794 in 1913, $8,515,332 in 1912, $8,283,777 in 1911, $4,704,088 in 1910, and $4,101,976 in 1909.

Cobalt.—No cobalt has been produced in the United States since 1909. The imports for consumption were valued at $95,735 in 1913, $83,080 in 1912, $59,151 in 1911, and $6,352 in 1910.

Titanium ore.—The Virginia mines reported 305 short tons of rutile concentrates, valued at $49,000, in 1913, and 275 short tons in 1912. No production of rutile was reported for 1911. A production estimated at $44,480 was reported in 1910, against $10,000 in 1909; none was reported in 1908. Imports of ferrotitanium were valued at $7,198 in 1913, $7,631 in 1912, $22,700 in 1911, and $767 in 1910.

Tungsten ore.—The commercial production of concentrated tungsten ore in 1913 was 1,537 short tons, valued at $672,118, against 1,330 short tons, valued at $502,158, in 1912; 1,139 short tons, valued at $407,985, in 1911; 1,821 short tons, valued at 832,992, in 1910; 1,619 short tons, valued at $614,370, in 1909; and the average annual production for the five preceding years of 956 short tons, valued at $384,309. The imports for consumption of tungsten ore were valued at $213,122 in 1913, $362,422 in 1912, $85,887 in 1911, $344,979 in 1910, and $105,506 in 1909. Tungsten and ferrotungsten were imported valued at $835,212 in 1913, $323,872 in 1912, and $143,802 in 1911.

Uranium and vanadium minerals.—There was a production in 1913 of uranium and vanadium ores from Colorado and Utah, whose estimated value of recoverable radium when extracted amounted to

$1,020,000. Both uranium and vanadium ores were produced in 1912. An output of vanadium valued at about $305,500 was reported for 1911; an output of vanadium was also reported for 1910 as in 1909, but no uranium. No output of either was reported for 1908. Imports for consumption of ferrovanadium valued at $2,623 were reported for 1911; none were reported for 1912 or 1913. Imports of uranium salts and oxide, including some radium salts, were valued at $42,180 in 1913, and $32,642 in 1912.

Tantalum minerals.—No production of tantalum minerals was reported for 1912 or 1913. A very small output of tantalum ore was reported as mined in 1911, as in 1910 and 1909; none seems to have been marketed in either year.

Platinum.—The production of refined platinum from domestic sources in 1913 was 1,034 ounces, valued at $46,530, compared with 1,005 ounces valued at $45,778, in 1912; 940 ounces, valued at $40,890 in 1911; 773 ounces, valued at $25,277, in 1910; 638 ounces, valued at $15,950, in 1909; and 613 ounces, valued at $15,907, the average annual production for the five years ending with 1908. The average price per ounce was $24.98 in 1909, $32.70 in 1910, $43.50 in 1911, $45.55 in 1912, and about $45.00 in 1913. The imports for consumption of platinum were valued at $5,040,210 in 1913, $4,503,682 in 1912, $4,866,207 in 1911, $3,654,664 in 1910, and $2,973,948 in 1909.

Iridium, osmium, palladium, and rhodium.—Imports of palladium, valued at $213,397, were reported for 1912 by the Bureau of Foreign and Domestic Commerce. In 1911 imports for consumption of these metals were: Iridium, $210,616; osmium, $25,476; palladium, $56,307—a total of $292,399. In 1910 these imports were: Iridium, $140,232; osmium, $32,647; palladium, $3,570; and rhodium, $4,356—a total of $180,805. No imports of these metals were reported to the Survey for 1913. The production of these metals from domestic ores in the United States is negligible.

Antimony.—No production of antimony has been reported for several years. The imports for consumption of antimony (metal, regulus, and ore) were valued at $936,361 in 1913, $859,917 in 1912, $531,011 in 1911, $539,755 in 1910, and $714,366 in 1909; imports of antimony salts were valued at $117,169 in 1913, and $81,077 in 1912.

Bismuth.—A domestic production of bismuth was reported for 1913; none was reported in 1912. The imports for consumption were valued at $213,257 in 1913, and $316,440 in 1912.

Tin.—About 84 short tons of tin ore, valued at $36,970, were reported for 1913, against 147 short tons, valued at $124,800, in 1912. In 1911 the output of tin ore was equivalent to 66 short tons of metallic tin, valued at $56,635, compared with a production valued at $23,447 in 1910. The imports of tin for consumption in 1913 were valued at $46,946,756, against $50,372,478 in 1912, $43,346,394 in 1911, and $33,913,255 in 1910.

Cadmium.—Cadmium was produced in 1913 as in previous years. The imports of cadmium for consumption were valued at $1,232 in 1913 and at $3,764 in 1912.

Selenium.—There was a small output of selenium in 1913 as in previous years.

Tellurium.—A small quantity of tellurium was obtained from copper anode muds in 1913.

FUELS.

Coal.—In 1906 the production of coal in the United States exceeded 400,000,000 short tons; in 1910, four years later, it exceeded half a billion tons, but in 1911 it fell a little short of this maximum. In 1912 the output was 534,466,580 short tons, valued at $695,606,071, against 496,371,126 short tons, valued at $626,565,211, in 1911; 501,596,378 short tons, valued at $629,557,021, in 1910; and 432,780,130 short tons, valued at $538,279,696, the average production for the five-year period from 1905 to 1909. In 1913 the production was 570,048,125 short tons, valued at $760,488,785.

Of this record-breaking total the output of anthracite in 1913 was 81,718,680 long tons, valued at $195,181,127, compared with 75,322,855 long tons, valued at $177,622,626, in 1912; 80,771,488 long tons, valued at $175,189,392, in 1911; and 75,433,246 long tons, valued at $160,275,302, in 1910. The increase in value in 1913 as compared with 1912 was $17,558,501. The average price of the anthracite coal actually sold during the season of 1913 at the mine was $2.39 per long ton, against $2.36 in 1912, $2.17 in 1911, $2.12 in 1910, and $2.06 in 1909.

The output of bituminous coal (which includes semianthracite and all semibituminous and lignite coals) amounted in 1913 to 478,523,203 short tons, valued at $565,307,658, compared with 450,104,982 short tons, valued at $517,983,445, in 1912; 405,907,059 short tons, valued at $451,375,819, in 1911; and 417,111,142 short tons, valued at $469,281,719, in 1910. The increase in the production of bituminous coal in 1913 over 1912 was, therefore, 28,418,221 short tons, or 6.31 per cent, in quantity and $47,324,213, or 9.14 per cent, in value. The average price of bituminous coal per ton at the mines was $1.18 in 1913, against $1.15 in 1912, $1.11 in 1911, and $1.12 in 1910.

The imports for consumption of anthracite were valued at $5,620 in 1913, and $8,329 in 1912; the imports of bituminous were valued at $3,853,930 in 1913, $4,509,066 in 1912, and $3,604,797 in 1911. The exports were: In 1913, anthracite, $21,759,850; bituminous, $45,449,664; in 1912, anthracite, $19,425,263; bituminous, $36,817,633.

Coal briquets.—The production of coal briquets in the United States in 1913 was 181,859 short tons, valued at $1,007,327, compared with 220,064 short tons, valued at $952,261, in 1912.

Coke.—The production of coke in 1913 amounted to 46,299,530 short tons (12,714,700 tons from retort ovens), valued at $128,922,273, against 43,983,599 short tons (11,115,164 tons from retort ovens), valued at $111,805,113, in 1912; 35,551,489 short tons (7,847,845 tons from retort ovens), valued at $84,130,849, in 1911; 41,708,810 short tons (7,138,734 tons from retort ovens), valued at $99,742,701, in 1910; 39,315,065 short tons (6,254,644 tons from retort ovens), valued at $89,065,483, in 1909; and 31,821,307 short tons, valued at $72,850,456, the average for the five years from 1904 to 1908, inclusive.

The average price per ton in 1913 was $2.78 against $2.54 in 1912, $2.37 in 1911, and $2.39 in 1910. The average output from the by-product ovens was 2,299 short tons per oven in 1913 and 2,133 tons per oven in 1912. The average output from beehive ovens was 505

short tons per oven in 1913 and 484 short tons per oven in 1912. The imports for consumption of coke were valued at $435,157 in 1913 and at $488,398 in 1912. The exports were valued at $3,309,930 in 1913, $3,002,742 in 1912, and $3,215,990 in 1911.

Natural gas.—The value of natural gas produced in 1913 was $87,846,677, compared with $84,563,957 in 1912, $74,621,534 in 1911, $70,756,158 in 1910, $63,206,941 in 1909, and $47,199,264, the average annual value for the preceding five-year period. No imports of natural gas have been reported since 1909, when the imports amounted to $6,060; in 1908 they were valued at $22,003.

The production of gasoline extracted from "casing-head gas" (natural gas from oil wells) amounted to 24,060,817 gallons, valued at $2,458,443, in 1913; 12,081, 179 gallons, valued at $1,157,476, in 1912; and 7,425,839 gallons, valued at $531,704, in 1911. The imports of gasoline were valued at $1,661 in 1913, against $118 in 1912. The exports were valued at $17,418,777 in 1913, against $4,671,815 in 1912.

Petroleum.—The total production of crude petroleum in 1913 was 248,446,230 barrels, valued at $237,121,388, against 222,935,044 barrels, valued at $164,213,247, in 1912; 220,449,391 barrels, valued at $134,044,752, in 1911; 209,557,248 barrels, valued at $127,899,688, in 1910; and 179,801,018 barrels, valued at $110,809,311, the average annual production for the years 1905 to 1909. The average price for crude petroleum per barrel in 1913 was 95.4 cents, against 73.7 cents in 1912, 60.8 cents in 1911, and 61 cents in 1910. The imports for consumption of petroleum in 1913 were valued at $12,947,280, against $6,082,881 in 1912, $2,410,884 in 1911, and $1,398,861 in 1910. The exports in 1913 were valued at $149,316,409, against $124,210,382 in 1912, $105,922,848 in 1911, and $94,107,022 in 1910.

The imports for consumption of ozokerite and paraffin in 1913 were valued at $982,352, against $1,018,524 in 1912, $792,818 in 1911, and $1,025,829 in 1910. The exports of paraffin and paraffin wax were valued at $8,176,831 in 1913, against $9,602,758 in 1912, $7,047,856 in 1911, $7,329,143 in 1910, $7,608,624 in 1909, and an average annual value of $8,348,043 for the years from 1904 to 1908, inclusive.

Peat.—The commercial production of peat in 1913, chiefly in the form of peat fertilizer filler and peat food for stock, was valued at $197,200, against $228,572 in 1912, $272,114 in 1911, and $140,209 in 1910. The imports of peat-moss litter have averaged $40,000 to $50,000 for the last seven or eight years.

STRUCTURAL MATERIALS.

Cement.—The total production of hydraulic cement in the United States was 92,949,102 barrels, valued at $93,001,169, compared with 83,351,191 barrels, valued at $67,461,513, in 1912; 79,547,958 barrels, valued at $66,705,136, in 1911; 77,785,141 barrels, valued at $68,752,092, in 1910; 66,689,715 barrels, valued at $53,610,563, in 1909; and 45,583,855 barrels, valued at $43,529,447, the average annual production for the years 1904 to 1908. The production of Portland cement in 1913 was 92,097,131 barrels, valued at $92,557,617, compared with 82,438,096 barrels, valued at $67,016,928, in 1912; 78,528,637 barrels, valued at $66,248,817, in 1911; and 76,549,951

barrels, valued at $68,205,800, in 1910. The production of natural cement in 1913 was 744,658 barrels, valued at $345,889, compared with 821,231 barrels, valued at $367,222, in 1912; 926,091 barrels, valued at $378,533, in 1911; and 1,139,239 barrels, valued at $483,006, in 1910. The production of puzzolan cement in 1913 amounted to 107,313 barrels, valued at $97,663, against 91,864 barrels, valued at $77,363, in 1912; 93,230 barrels, valued at $77,786, in 1911; and 95,951 barrels, valued at $63,286, in 1910. The imports for consumption of hydraulic cement were valued at $138,187 in 1913, $93,558 in 1912, $242,722 in 1911, and $395,526 in 1910. The exports were valued at $4,270,666 in 1913, $6,160,341 in 1912, $4,632,215 in 1911, and $3,477,981 in 1910.

Clay.—Clay mined and sold as unmanufactured clay was valued at $4,180,459, against $3,946,020 in 1912.

Clay products.—The value of all clay products in 1913 as reported to the Geological Survey was $181,289,132, compared with $172,811,275 in 1912, $162,236,181 in 1911, $170,115,974 in 1910, and $153,838,171, the average annual value for the five preceding years. The pottery products were valued at $37,992,375 in 1913, $36,504,164 in 1912, $34,518,560 in 1911, and $33,784,678 in 1910. The imports for consumption of pottery in 1913 amounted to $10,177,451, against $9,555,530 in 1912, $10,638,616 in 1911, and $11,131,158 in 1910. The imports of brick in 1913 were valued at $276,677, against $215,379 in 1912. The exports of brick were valued at $4,229,076 in 1913 and $3,823,111 in 1912, and the exports of pottery at $559,163 in 1913 and $1,177,784 in 1912. The imports of kaolin or china clay were valued at $1,623,993 in 1913 and $1,629,105 in 1912. The imports of other clays amounted to $382,782 in 1913, against $323,131 in 1912.

Glass sand.—The production of glass sand in 1913 was 1,791,800 short tons, valued at $1,895,991, compared with 1,465,386 short tons, valued at $1,430,471, in 1912; 1,538,666 short tons, valued at $1,543,733, in 1911; 1,461,089 short tons, valued at $1,516,711, in 1910; and $1,172,912, the average annual value for the period from 1905 to 1909.

Gypsum.—The output of crude gypsum in 1913 was 2,599,508 short tons, valued in its first marketable condition at $6,774,822, compared with 2,500,757 short tons, valued at $6,563,908, in 1912; 2,323,970 short tons, valued at $6,462,035, in 1911; 2,379,057 short tons, valued at $6,523,029, in 1910; and an annual average value of $4,358,406 for the five years from 1905 to 1909. The imports for consumption were valued at $556,922 in 1913, $488,481 in 1912, and $450,806 in 1911.

Lime.—The production of lime in 1913 was 3,595,390 short tons, valued at $14,648,362, against 3,529,462 short tons, valued at $13,970,114, in 1912; 3,392,915 short tons, valued at $13,689,054, in 1911; 3,505,954 short tons, valued at $14,088,039, in 1910; and $12,203,259, the average annual value for the years 1905 to 1909. The average price per short ton was $4.07 in 1913, $3.96 in 1912, $4.03 in 1911, and $4.02 in 1910. The imports for consumption in 1913 were 4,139 short tons, valued at $48,538, against 4,268 short tons, valued at $48,153, in 1912. The exports reported were valued at $212,345 in 1913 and $199,515 in 1912.

Sand and gravel.—The production of sand for molding, building, engine, furnace, and other uses and of gravel reported in 1913 was

77,764,049 short tons, valued at $22,321,517, against 66,889,175 short tons, valued at $21,682,737, in 1912; 65,308,293 short tons, valued at $19,614,850, in 1911; and 67,949,347 short tons, valued at $19,520,919, in 1910. The imports for consumption of sand were valued at $172,257 in 1913 and $141,690 in 1912.

Sand-lime brick.—The production of sand-lime brick was valued at $1,238,325 in 1913, $1,200,223 in 1912, $897,664 in 1911, $1,169,153 in 1910, and an average of $1,109,625 for the five-year period from 1905 to 1909.

Slate.—The production of slate in 1913 was valued at $6,175,476, against $6,043,318 in 1912, $5,728,019 in 1911, $636,236,759 in 1910, and $5,792,402, the average annual value for the period 1905 to 1909. The imports of slate were valued at $5,479 in 1913 and $14,768 in 1912. The exports of roofing slate were not reported separately in 1912, 1911, or 1910; in 1913 they were valued at $226,413; in 1909 at $209,383; in 1908 at $197,216.

Stone.—The value of all kinds of stone produced in the United States in 1913 amounted to $83,732,995, compared with $78,193,220 in 1912, $77,108,567 in 1911, and $76,520,584 in 1910; the annual average value for the period 1905 to 1909 was $67,868,209. The imports for consumption of marble and stone were valued in 1913 at $1,606,135, against $1,562,231 in 1912; the exports were valued at $1,856,892 in 1913, against $1,839,878 in 1912.

Included under stone is the limestone used for fluxing in blast furnaces, which was 22,620,961 long tons, valued at $11,103,989, in 1913; compared with 20,190,554 long tons, valued at $9,937,772, in 1912; 16,126,560 long tons, valued at $7,987,208, in 1911; 18,203,882 long tons, valued at $9,345,733, in 1910; 15,772,863 long tons, valued at $7,921,807, in 1909; and an average production of 14,066,574 long tons, valued at $6,873,891, for the years from 1904 to 1908.

ABRASIVE MATERIALS.

Artificial abrasives.—The total production of the artificial abrasives—alundum, carborundum, and crushed steel—in 1913 amounted to 33,489,000 pounds, valued at $2,017,458, against 29,002,000 pounds, valued at $1,747,120, in 1912.

Emery and corundum.—No domestic corundum has been produced since 1906. The output of emery was 957 short tons, valued at $4,785, in 1913, against 992 short tons, valued at $6,652, in 1912. The imports for consumption were valued at $474,299 in 1913 and $491,725 in 1912.

Garnet.—The production of abrasive garnet during 1913 amounted to 5,308 short tons, valued at $183,422, against 4,947 short tons, valued at $163,237, in 1912; 4,076 short tons, valued at $121,748, in 1911; 3,814 short tons, valued at $113,574, in 1910; and $136,742, the annual average value for the years 1905 to 1909.

Grindstones.—The total value of all kinds of grindstones and pulp stones produced in 1913 was $855,627, against $916,339 in 1912, $907,316 in 1911, $796,294 in 1910, and $751,734, the average annual value for the period 1905 to 1909. The imports were valued at $139,386 in 1913 and $131,080 in 1912.

Diatomaceous (infusorial) earth and tripoli.—The value of the diatomaceous (infusorial) earth and tripoli produced in 1913 was $285,821,

against $125,446 in 1912, $147,462 in 1911, $130,006 in 1910, and $92,068, the average annual value for the years 1905 to 1909. The imports for consumption of rottenstone and tripoli were valued at $28,696 in 1913 and $24,253 in 1912.

Millstones and burrstones.—The value of the production of millstones and burrstones in 1913 was $56,163, against $71,414 in 1912. The imports for consumption were valued at $40,198 in 1913 and $27,562 in 1912.

Oilstones and whetstones.—The production of oilstones and whetstones in 1913 was valued at $207,352, against $232,218 in 1912, $214,991 in 1911, $228,694 in 1910, $214,019 in 1909, and the average annual value of $236,615 for the five years 1904 to 1908. The imports for consumption were valued at $40,222 in 1913 and $45,398 in 1912.

Pumice.—The production of pumice amounted to 24,563 short tons, valued at $55,408, in 1913, against 27,146 short tons, valued at $86,687, in 1912, and 21,689 short tons, valued at $88,399, in 1911. The imports for consumption were valued at $93,408 in 1913, $74,478 in 1912, and $118,977 in 1911.

CHEMICAL MATERIALS.

Arsenious oxide.—The domestic production of arsenious oxide (white arsenic) in 1913 amounted to 5,026,000 pounds, valued at $159,236, against 6,282,000 pounds, valued at $190,757, in 1912, and 6,264,000 pounds, valued at $73,408, in 1911. The imports for consumption of white arsenic, metallic arsenic, and arsenic sulphide were valued at $410,446 in 1913 and $428,741 in 1912.

Borax.—The reported returns for 1913 gave an aggregate production of crude borax of 58,051 short tons, valued at $1,491,530, against 42,315 short tons, valued at $1,127,813, in 1912, and 53,330 short tons, valued at $1,569,151, in 1911. The imports for consumption of borax were valued at $18,434 in 1913 and $11,249 in 1912.

Bromine.—The production of bromine in 1913 amounted to 572,400 pounds, valued at $115,436, against 647,200 pounds, valued at $145,805, in 1912; 651,541 pounds, valued at $110,902, in 1911; and 245,437 pounds, valued at $31,684, in 1910.

Calcium chloride.—The production of calcium chloride in 1913 was 19,611 short tons, valued at $130,030, against 18,550 short tons, valued at $117,272, in 1912; 14,606 tons, valued at $91,215, in 1911; and 10,971 tons, valued at $74,713, in 1910.

Fluorspar and cryolite.—The commercial production of fluorspar in 1913 was 115,580 short tons, valued at $736,286, compared with 116,545 short tons, valued at $769,163, in 1912; 87,048 short tons, valued at $611,447, in 1911; 69,427 short tons, valued at $430,196, in 1910; and 47,439 short tons, valued at $282,320, the average production for the years 1905 to 1909. The imports for consumption in 1912 were 26,176 short tons, valued at $71,616, and in 1913 they were 22,682 short tons, valued at $71,463. The imports of cryolite were valued at $52,557 in 1913 and $48,293 in 1912.

Lithium minerals.—No production of lithium minerals was reported in 1911 or 1912; the production in 1913 was small, as in 1909 and 1910, and the figures may not be published.

Marls.—No considerable production of marls has been reported since 1908. There was a very small output in 1913.

Phosphate rock.—The total commercial marketed production of phosphate rock reported to the Survey in 1913 amounted to 3,111,221 long tons, valued at $11,796,231, compared with 2,973,332 long tons, valued at $11,675,774, in 1912; 3,053,279 long tons, valued at $11,900,693, in 1911; 2,654,988 long tons, valued at $10,917,000, in 1910; and $9,638,396, the average annual value for the years 1905 to 1909. The total quantity of phosphate rock reported as mined during 1913 was 3,152,208 long tons, against 3,190,587 long tons in 1912. The imports for consumption of crude phosphate, guano, kainite, manure salts, etc., in 1913 were valued at $10,819,253, against $8,893,090 in 1912. The exports of phosphate rock in 1913 were 1,366,508 long tons, valued at $9,996,580, against 1,206,520 long tons, valued at $8,996,456, in 1912, and 1,246,577 long tons, valued at $9,235,388, in 1911.

Potash salts.—There was no actual production of potash salts in the United States in 1913. The imports of potash salts in 1913 were valued at $10,793,913, against $10,692,285 in 1912.

Salt.—The salt product includes salt in the form of brine used in large quantities for the manufacture of soda ash, sodium bicarbonate, caustic soda, and other sodium salts. The domestic production of salt in 1913 amounted to 34,399,298 barrels of 280 pounds, valued at $10,123,139, compared with 33,324,808 barrels, valued at $9,402,772, in 1912; 31,183,968 barrels, valued at $8,345,692, in 1911; 30,305,656 barrels, valued at $7,900,344, in 1910; and $7,252,012, the value of the average annual output 1905 to 1909. The imports for consumption in 1913 were valued at $421,745, against $370,648 in 1912. The exports were valued at $515,194 in 1913 and $418,525 in 1912.

Sodium nitrate.—The imports of sodium nitrate for consumption in manufacutre of fertilizers and other chemical products amounted in value to $21,630,811 in 1913, against $16,544,511 in 1912, and $16,814,268 in 1911.

Sulphur and pyrite.—The domestic production of sulphur in 1913 was 311,590 long tons, valued at $5,479,849, against 303,472 long tons, valued at $5,256,422, in 1912; 265,664 long tons, valued at $4,787,049, in 1911; 255,534 long tons, valued at $4,605,112, in 1910; and 275,538 long tons, valued at $5,009,274, the average annual production for the years 1905 to 1909. The production of pyrite in 1913 was 341,338 long tons, valued at $1,286,084, against 350,928 long tons, valued at $1,334,259, in 1912; 301,458 long tons, valued at $1,164,871, in 1911; 241,612 long tons, valued at $977,978, in 1910; 246,295 long tons, valued at $910,003, the average annual production for the five years 1905 to 1909. The imports for consumption of sulphur fell in value from $558,611 in 1910 to $552,836 in 1911, rose to $583,974 in 1912, and fell to $448,564 in 1913. The exports in 1913 amounted to 89,221 long tons, valued at $1,599,761, against 57,736 long tons, valued at $1,076,414, in 1912; 28,103 long tons, valued at $545,420, in 1911; 30,742 long tons, valued at $552,941, in 1910. The imports for consumption of pyrite were valued at $3,611,137 in 1913, $3,841,683 in 1912, $3,788,803 in 1911, $2,748,647 in 1910, and $2,428,580 in 1909.

Sulphuric acid from copper and zinc smelters.—The production of sulphuric acid from the fumes of copper and zinc smelters was reported

for the first time in 1911. It amounted to 438,300 short tons (60° Baumé), valued at $2,733,696, in 1911; 614,073 short tons, valued at $4,240,941, in 1912; and 632,237 short tons, valued at $4,346,272, in 1913.

PIGMENTS.

Barytes.—The production of crude barytes in 1913 was 45,298 short tons, valued at $156,275, as compared with 37,478 short tons, valued a $153,313, in 1912; 38,445 short tons, valued at $122,792, in 1911; 42,975 short tons, valued at $121,746, in 1910; 61,945 short tons, valued at $209,737, in 1909; 58,468 short tons, valued at $179,269, the average annual production for the five years from 1904 to 1908. The imports for consumption were valued at $99,564 in 1913, and $79,315 in 1912. The imports of barium compounds were valued at $391,470 in 1913 and $376,017 in 1912.

Strontium salts, valued at $2,284 were imported in 1913; no imports were reported for 1911 or 1912.

Cobalt oxide.—The production of cobalt oxide in 1908 and 1909 was included under unspecified products. No production has been reported since 1909. A production was reported from Oregon and Missouri in 1907. The imports for consumption were valued at $95,735 in 1913 and $83,080 in 1912.

Mineral paints.—The commercial production of mineral paints (zinc oxide included) in 1913 amounted to 173,168 short tons, valued at $9,543,306, compared with 181,154 short tons, valued at $10,069,588, in 1912; and 143,350 short tons, valued at $7,842,582, in 1911. The production (zinc oxide excluded) was 85,685 short tons, valued at $2,174,735, in 1910; and 78,771 short tons, valued at $2,373,805, in 1909. Imports for consumption of ocher were valued at $143,720 in 1913, against $148,306 in 1912; and $110,932 in 1911; of sienna, at $48,535 in 1913, and $45,794 in 1912; of umber, at $36,771 in 1913 and $31,626 in 1912.

Zinc oxide.—The production of zinc oxide in 1911, 1912, and 1913 may not be separately reported; it amounted to 58,481 short tons, valued at $5,238,945, in 1910; 68,974 short tons, valued at $6,156,755, in 1909; and 66,944 short tons, valued at $5,578,243, the average production for the years 1904 to 1908. The imports for consumption of zinc oxide were valued at $434,156 in 1913, $386,153 in 1912, and $357,466 in 1911. The exports were valued at $1,136,257 in 1913 and $1,247,702 in 1912.

MISCELLANEOUS.

Asbestos.—The asbestos commercially produced in the United States in 1913 was from Georgia and Arizona; in 1912 it was obtained from deposits in Vermont, Georgia, and Wyoming; in 1911 Virginia also had a production. The total commercial production in 1913 was 1,100 short tons, valued at $11,000, against 4,403 short tons, valued at $87,959, in 1912; 7,604 short tons, valued at $119,935, in 1911; 3,693 short tons, valued at $68,357, in 1910; and 1,896 short tons, valued at $33,133, the annual average production for 1905 to 1909. The imports for consumption were valued at $2,307,666 in 1913, $1,819,771 in 1912, $1,703,639 in 1911, and $1,543,248 in 1910.

Asphalt.—Under the term of "asphalt" are included the various bitumens or hydrocarbons not discussed elsewhere under the head-

ing "Petroleum." The commercial production in 1913 was 529,190 short tons, valued at $5,282,370, compared with 449,510 short tons, valued at $4,620,731, in 1912; 364,266 short tons, valued at $3,991,109, in 1911; 260,080 short tons, valued at $3,080,067, in 1910; and 180,845 short tons, valued at $1,812,227, the average production for the five preceding years. The imports of asphalt were valued at $910,611 in 1913, $921,145 in 1912, and $789,236 in 1911. The exports for the fiscal year 1913 were valued at $1,640,027, against $1,170,882 in 1912.

Feldspar.—The production of feldspar in 1913 was 120,955 short tons, valued at $776,551, compared with 86,578 short tons, valued at $520,562, in 1912; 92,700 short tons, valued at $579,008, in 1911; 81,102 short tons, valued at $502,452, in 1910; and 76,539 short tons, valued at $424,602, in 1909.

Fertilizers.—Fertilizers, including apatite, bone dust, guano, kainite, kierserite, crude phosphates, and other manures, are reported under phosphate rock and under potash salts.

Fuller's earth.—As reported to the Survey, the production of fuller's earth in 1913 was 38,594 short tons, valued at $369,750, against 32,715 short tons, valued at $305,522, in 1912; 40,697 short tons, valued at $383,124, in 1911; 32,822 short tons, valued at $293,709, in 1910; and against an average annual production for the years 1905 to 1909 of 30,654 short tons, valued at $270,328. The imports for consumption were valued at $146,001 in 1913 and $145,337 in 1912.

Gems and precious stones.—The value of gems and precious stones found in the United States in 1913 was reported at $319,454, against $319,722 in 1912, $343,692 in 1911, $295,797 in 1910, and $534,380 in 1909. Pearls produced in 1907 were valued at $264,500, against $381,000 in 1906. No production of pearls has been reported since 1907. Imports of precious stones in 1913 were valued at $45,431,998, against $41,363,325 in 1912, $40,820,436 in 1911, $40,704,487 in 1910, $40,237,509 in 1909, and an annual average of $30,648,792 for the years 1904 to 1908.

Graphite.—The commercial production of crystalline graphite during 1913 amounted to 5,064,727 pounds, valued at $254,328, compared with 3,543,771 pounds, valued at $187,689 in 1912; 4,790,000 pounds, valued at $256,050, in 1911; 5,590,592 pounds, valued at $295,733, in 1910; and $218,579, the average annual value for the period from 1905 to 1909. The production of amorphous graphite in 1913 was 2,243 short tons, valued at $39,428, compared with 2,063 short tons, valued at $32,894, in 1912; 1,223 short tons, valued at $32,415, in 1911; 1,407 short tons, valued at $39,710, in 1910; and $83,225, the average annual value for the period from 1905 to 1909. The production of manufactured graphite in 1913 was 13,633,342 pounds, valued at $973,397, the average price being 7.14 cents per pound, compared with 12,896,347 pounds, valued at $830,193, in 1912, the average price being 6.44 cents per pound. The imports for consumption of graphite in 1913 were valued at $2,109,791, against $1,709,337 in 1912, $1,495,729 in 1911, $1,872,592 in 1910, $1,854,459 in 1909, and $762,367 in 1908.

Magnesite.—The production of crude magnesite continues to be limited to California. During 1913 the commercial production was 9,632 short tons, valued at $77,056, against 10,512 short tons, valued

at $84,096, in 1912; 9,375 short tons, valued at $75,000, in 1911; 12,443 short tons, valued at $74,658, in 1910; and 7,070 short tons, valued at $23,782, the average for 1905 to 1909. The imports for consumption of magnesite and magnesia in 1913 were valued at $1,860,557, against $1,430,542 in 1912.

Mica.—The total production of mica in 1913 was 1,700,677 pounds of sheet mica, valued at $353,517, and 5,322 short tons of scrap mica, valued at $82,543, against 845,483 pounds of sheet mica, valued at $282,823, and 3,226 short tons of scrap mica, valued at $49,073, in 1912; 1,887,201 pounds of sheet mica, valued at $310,254, and 3,512 short tons of scrap mica, valued at $45,550, in 1911; 2,476,190 pounds of sheet mica, valued at $283,832, and 4,065 short tons of scrap mica, valued at $53,265, in 1910; and annual values for the years 1905 to 1909 of $246,159 for sheet mica and $32,669 for scrap mica. The imports for consumption of mica were valued at $943,018 in 1913, $748,973 in 1912, $502,163 in 1911, and $724,525 in 1910.

Mineral waters.—The total production of mineral waters in 1913 was 57,867,399 gallons, valued at $5,631,391, compared with 62,281,-201 gallons, valued at $6,615,671, in 1912; 63,788,552 gallons, valued at $6,837,888, in 1911; 62,030,125 gallons, valued at $6,357,590, in 1910; 64,674,486 gallons, valued at $6,894,134, in 1909; and the average production of 48,910,285 gallons, valued at $6,956,539, for the years 1904 to 1908. The imports for consumption of mineral waters were valued at $955,788 in 1913 and $930,091 in 1912.

Monazite and zircon.—The production of monazite declined from a maximum of 1,352,418 pounds, valued at $163,908, in 1905, to 99,301 pounds, valued at $12,006, in 1910. There has been no production since 1910, and the gas-mantle industry of the United States has been supplied by imports of monazite from Brazil and of manufactured thorium salts from Germany.

The imports for consumption of thorium nitrate in 1913 were 119,044 pounds, valued at $230,628, against 117,485 pounds, valued at $225,386, in 1912; 121,111 pounds, valued at $238,841, in 1911; 124,808 pounds, valued at $219,615, in 1910; 127,833 pounds, valued at $236,057, in 1909; and 65,289 pounds, valued at $173,239, in 1908. The imports of monazite and thorium oxide in 1913 were valued at $68,543, against $47,334 in 1912, $60,542 in 1911, $48,199 in 1910, and $27,920 in 1909.

The production of zircon has always been irregular in the United States, but has been smaller in the last several years than before. From a production of 26 tons in 1883 the production has declined to a few thousand pounds each year, and to nothing in 1912 and 1913.

Silica (quartz).—The production of silica (quartz) in 1913 was 204,759 short tons, valued at $668,011, against 97,874 short tons, valued at $191,685, in 1912; 87,943 short tons, valued at $155,122, in 1911; 63,577 short tons, valued at $193,757, in 1910; and 135,469 short tons, valued at $249,466, in 1909. The value of the unground flint stones imported for consumption in 1913 was $319,509, against $292,052 in 1912 and $236,158 in 1911.

Talc and soapstone.—Exclusive of the production of fibrous talc from Gouverneur, N. Y., the production of talc and soapstone in 1913 amounted to 94,128 short tons, valued at $1,119,597, compared with 92,403 short tons, valued at $1,050,693, in 1912; 81,521 short tons, valued at $1,032,732, in 1911; 79,006 short tons, valued at $864,213,

in 1910; and 60,086 short tons, valued at $796,460, the average annual production for the five-year period from 1905 to 1909. The imports for consumption of talc were valued at $137,680 in 1913, and $122,956 in 1912.

Fibrous talc.—In 1913 the production of fibrous talc was 81,705 short tons, valued at $788,500, against 66,867 short tons, valued at $656,270, in 1912; 62,030 short tons, valued at $613,286, in 1911; 71,710 short tons, valued at $728,180, in 1910; and 61,049 short tons, valued at $537,109, the average annual production for the years 1905–1909.

MINERAL PRODUCTS OF THE UNITED STATES, IN 1912 AND 1913, BY SUBSTANCES.

From the following tabular statement headed "Mineral products of the United States in 1912 and 1913," all unnecessary duplication has been excluded. The manufactured coke product, amounting in 1913 to 46,299,530 short tons and valued at $128,922,273, is excluded, as the quantity and value of the coal used in its manufacture are included in the statistics of coal production. Similarly, white lead, red lead, lithopone, Venetian red, litharge, and orange mineral, whose average aggregate value for the last 10 years has largely exceeded $15,000,000, are not given in the table, the base from which they are made being included in the output of pig lead. Zinc white or zinc oxide, zinc-lead, sublimed blue lead, and sublimed white lead, on the other hand, made directly from the ores, and consequently not included in zinc or lead production, are tabulated. The production of pig iron and its value are given in the table as the best means of presenting the statistics of the production of iron in the first marketable condition, the value of iron ores being excluded. Similarly, the value of the products of the clay industries is given as being the first marketable condition of the greater part of the clay produced, although the production and value of the clay mined and sold in the raw state by clay miners to manufacturers of clay are elsewhere shown separately, but are not included in the tabular statement, in order to avoid duplication.

Since the report for 1905, inclusive, the figures for gold and silver have been the official figures agreed upon by the United States Geological Survey and the Director of the Mint.

	Product.	1912		1913		Increase (+) or decrease (−) in 1913.		Percentage of increase (+) or decrease (−) in 1913.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	METALS.								
1	Pig iron[a] (spot value[b]), long tons (2,240 lbs.)	30,180,969	$420,563,388	30,388,935	$458,342,345	+ 207,966	+$37,778,957	+ 0.69	+ 8.98
2	Ferro-alloys[c] long tons	328,685	12,223,776	296,207	13,015,362	− 32,478	+ 791,586	− 9.88	+ 6.48
3	Silver, commercial value[d] troy ounces	63,766,800	39,197,500	66,801,500	40,348,100	+ 3,034,700	+ 1,150,600	+ 4.76	+ 2.94
4	Gold, coining value[e] do	4,520,717	93,451,500	4,299,784	88,884,400	− 220,933	− 4,567,100	− 4.89	− 4.89
5	Copper, f value at New York pounds	1,243,268,720	205,139,338	1,224,484,098	189,795,035	−18,784,622	− 15,344,303	− 1.50	− 7.43
6	Lead, f value at New York, short tons (2,000 lbs.)	415,395	37,385,550	436,430	38,405,840	+ 21,035	+ 1,020,290	+ 5.06	+ 2.73
7	Zinc, f value at St. Louis short tons	323,907	44,699,166	337,252	37,772,224	+ 13,345	− 6,926,942	+ 4.10	− 15.50
8	Quicksilver, value at San Francisco, flasks (75 lbs. net)	25,064	1,053,941	20,213	813,171	− 4,851	− 240,770	− 19.35	− 22.84
9	Aluminum (consumption) pounds	65,607,000	11,907,000	72,379,000	13,845,000	+ 6,772,000	+ 1,938,000	+ 10.32	+ 16.27
10	Antimony[g] short tons								
11	Antimonial lead do	13,552	1,311,348	16,665	1,675,179	+ 3,113	+ 363,831	+ 22.97	+ 27.74
12	Nickel, value at New York pounds		(h)		(h)				
13	Tin do		124,800		36,970		− 87,930		− 70.46
14	Platinum, value at New York troy ounces	1,005	45,778	1,034	46,530	+ 29	+ 752	+ 2.89	+ 1.64
15	Total value of metals		867,103,085		882,980,156		+ 15,877,071		+ 1.83
	NONMETALS (spot value).								
16	Bituminous coal[i] short tons	450,104,982	517,983,445	478,523,203	565,307,658	+28,418,221	+ 47,324,213	+ 6.31	+ 9.14
17	Pennsylvania anthracite long tons	75,322,855	177,622,626	81,718,680	195,181,127	+ 6,395,825	+ 17,558,501	+ 8.49	+ 9.80
18	Natural gas		84,563,957		87,846,677		+ 3,282,720		+ 3.88
19	Petroleum barrels (42 gals.)	222,935,044	164,213,247	248,446,230	237,121,388	+25,511,186	+ 72,908,141	+ 11.44	+ 44.40

[a] Marketed production of iron ore—1912: 57,017,614 long tons; value at mines, $107,050,153; 1913: 59,643,098 long tons; value at mines, $130,905,558.
[b] By "spot" value is meant value at the point of production.
[c] Ferro-alloys include ferromanganese and spiegeleisen, ferrosilicon and ferrophosphorus, ferromolybdenum, ferrotitanium, ferrotungsten, and ferrovanadium. The ferro-alloys are made chiefly of foreign ores. Pig iron in 1910 included ferro-alloys valued at $7,423,502.
[d] Average price per troy ounce in 1912 was 61.5 cents; in 1913, 60.4 cents.
[e] Prior to 1905, coining value $20.6718 per troy ounce; in 1905, coining value, $20.671834; since 1905, coining value, $20.671834625323.
[f] The product from domestic ores only.
[g] No production in 1912 and 1913.
[h] Included under unspecified products.
[i] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania. Coke—1912: 43,893,599 short tons; value at ovens, $111,805,113; 1913: 46,299,530 short tons; value at ovens, $128,922,273.

Mineral products of the United States in 1912 and 1913—Continued.

	Product.	1912		1913		Increase (+) or decrease (−) in 1913.		Percentage of increase (+) or decrease (−) in 1913.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	NONMETALS (spot value)—continued.								
20	Peat		$228,572		$197,200		− $31,372		−$15.91
21	Clay products [a]		172,811,275		181,289,132		+ 8,477,857		+ 4.91
22	Cement.....barrels (380 lbs. net)	83,351,191	67,461,513	92,949,102	93,001,169	+ 9,579,911	+ 25,539,656	+ 11.51	+ 37.86
23	Glass sand.....short tons	1,465,386	1,430,471	1,791,800	1,895,991	+ 326,414	+ 465,520	+ 22.27	+ 32.54
24	Gypsum.....do	2,500,757	6,563,908	2,599,508	6,774,822	+ 98,751	+ 210,914	+ 3.95	+ 3.21
25	Lime.....do	3,529,462	13,970,114	3,595,390	14,648,362	+ 65,928	+ 678,248	+ 1.87	+ 4.85
26	Sand (molding, building, etc.) and gravel, short tons	66,889,175	21,682,737	77,764,049	22,321,517	+10,874,874	+ 638,780	+ 16.25	+ 2.94
27	Sand-lime brick		1,200,223		1,238,325		+ 38,102		+ 3.17
28	Slate		6,043,318		6,175,476		+ 132,158		+ 2.19
29	Stone [b]		78,193,220		83,732,995		+ 5,539,775		+ 7.08
30	Corundum and emery.....short tons	992	6,652	957	4,785	− 35	− 1,867	− 3.50	− 38.00
31	Abrasive quartz and feldspar.....do	(c)	(c)	(c)	(c)				
32	Garnet, abrasive.....do	4,947	163,237	5,308	183,422	+ 361	+ 20,185	+ 6.80	+ 11.00
33	Grindstones		916,339		855,627		− 60,712		+ 6.63
34	Diatomaceous earth and tripoli.short tons		125,446		285,821		+ 160,375		+127.84
35	Millstones		71,414		56,163		− 15,251		− 21.36
36	Oilstones, etc		232,218		207,352		− 24,866		− 10.70
37	Pumice.....short tons	27,146	86,687	24,563	55,408	− 2,583	− 31,279		− 9.50
38	Arsenious oxide.....pounds	6,282,000	190,757	5,026,000	159,236	− 628	− 31,521	− 19.99	− 16.52
39	Borax, crude.....short tons	42,315	1,127,813	58,051	1,491,530	+ 15,736	+ 363,717	+ 37.19	+ 32.25
40	Bromine.....pounds	647,200	145,805	572,400	115,436	− 74,800	− 30,369	− 11.56	− 20.83
41	Calcium chloride.....short tons	18,550	117,272	19,611	130,030	+ 1,061	+ 12,758	+ 5.72	+ 10.88
42	Fluorspar.....do	116,545	769,163	115,580	736,296	− 965	− 32,877	− .83	− 4.27
43	Lithium minerals.....lo								
44	Marls.....do								
45	Phosphate rock.....long tons	2,973,332	11,675,774	3,111,221	11,796,231	+ 137,889	+ 120,457	+ 5.00	+ 1.00
46	Pyrite.....do	350,928	1,334,259	341,338	1,286,084	− 9,590	− 48,175	− 2.73	− 3.61
47	Sulphur.....do	303,472	5,256,422	311,590	5,479,849	+ 8,118	+ 223,427	+ 1.68	+ 4.25
48	Sulphuric acid (60° Baumé, from copper and zinc smelters).....short tons	614,073	4,240,941	632,237	4,346,272	+ 18,164	+ 105,331	+ 2.96	+ 2.48
49	Salt.....barrels (280 lbs. net)	33,324,808	9,402,772	34,399,298	10,123,139	+ 1,074,490	+ 720,367	+ 3.22	+ 7.66
50	Barytes, crude.....short tons	37,478	153,313	45,298	156,275	+ 7,820	+ 2,962	+ 20.87	+ 1.93
51	Mineral paints [d].....do	181,154	10,069,588	173,168	9,543,306	− 7,986	− 526,282	− 4.41	− 5.20
52	Zinc oxide.....do								
53	Asbestos.....do	4,403	87,959	1,100	11,000	− 3,303	− 76,959	− 75.02	− 87.49
54	Asphalt.....do	449,510	4,620,731	529,190	5,282,370	+ 79,680	+ 661,639	+ 17.72	+ 14.32
55	Bauxite.....long tons	159,865	768,932	210,241	997,698	+ 50,376	+ 228,766	+ 31.50	+ 29.80
56	Chromic iron ore.....do	201	2,753	255	2,854	+ 54	+ 101	+ 26.86	+ 3.66

57	Feldspar, short tons	86,572	520,562	120,955	776,551	+ 34,383	+ 255,989	+ 39.72	+ 49.18
58	Fuller's earth, do	32,715	305,522	38,594	369,750	+ 5,879	+ 64,228	+ 17.97	+ 21.02
59	Gems and precious stones		319,722		319,454		− 268		− .08
60	Graphite, crystalline, pounds	3,543,771	187,689	5,064,727	254,328	+ 1,520,956	+ 66,639	+ 42.92	+ 35.51
	Graphite, amorphous, short tons	2,063	32,894	2,243	39,428	+ 180	+ 6,534	+ 8.73	+ 19.86
61	Magnesite, short tons	10,512	84,096	9,632	77,056	− 880	− 7,040	− 8.37	− 8.37
62	Manganese ore, long tons	1,664	15,723	4,048	40,480	+ 2,384	+ 24,757	+143.27	+157.46
63	Manganiferous ore, do	51,517	19,942	59,403	25,124	+ 7,886	+ 9,401	+ 15.31	+ 59.79
64	Mica, sheet, pounds	845,483	282,823	1,700,677	353,517	+ 855,194	+ 70,694	+101.15	+ 24.99
	Mica, scrap, short tons	3,226	49,073	5,322	82,543	+ 2,056	+ 33,470	+ 62.95	+ 68.20
65	Mineral waters, gallons sold	62,281,201	6,615,671	57,867,399	5,631,391	− 4,413,802	− 984,280	− 7.00	− 15.00
66	Silica (quartz), short tons	97,847	191,685	204,759	668,011	+ 106,912	+ 476,326	+109.26	+248.49
67	Talc and soapstone, do	92,403	1,050,693	94,128	1,119,597	+ 1,725	+ 68,904	+ 1.87	+ 6.56
68	Talc, fibrous, do	66,867	656,270	81,705	788,500	+ 14,838	+ 132,230	+ 22.19	+ 20.15
69	Thorium minerals (monazite) and zircon, pounds								
70	Titanium ore (rutile), pounds	550,000	(e)	610,000	49,000				
71	Tungsten ore, short tons	1,330	502,158	1,537	672,118	+ 207	+ 169,960	+ 15.56	+ 33.85
72	Uranium and vanadium minerals, do		(e)		f 1,020,000				
73	Total value of nonmetals		1,376,369,396		1,562,324,861		+185,955,465		+ 13.51
74	Total value of metals		867,103,085		882,980,156		+ 15,877,071		+ 1.83
75	Estimated value of mineral products unspecified g		500,000		500,000				
76	Grand total		2,243,972,481		2,445,805,017		+201,832,536		+ 8.99

a Value of clay mined and sold as unmanufactured clay—1912: $3,946,020; 1913: $4,180,459.
b Includes limestone for iron flux, but not grindstones.
c Included under feldspar and silica (quartz).
d Includes since 1904 metallic paint, mortar colors, ocher, umber, sienna, shale, ground slate; since 1907, also sublimed blue lead, sublimed white lead, zinc-lead, and leaded zinc oxide; in 1910, also whiting; in 1911 and 1912, also zinc oxide; in 1913, also zinc oxide, but no whiting or zinc-lead.
e Included under unspecified products.
f Estimated recoverable value of radium in ore when extracted.
g Unspecified products include nitrate of soda, carbonate of soda, sulphate of soda, and alum clays used by paper manufacturers, and also the various products noted. The value was estimated at $500,000 in 1913.

Mineral products of the United States

	Product.	1880	
		Quantity.	Value.
	METALS.		
1	Pig iron, value at Philadelphia.....long tons..	3,375,912	$89,315,569
2	Silver, commercial value.....troy ounces..	30,318,700	34,717,000
3	Gold, coining value.....do....	1,741,500	36,000,000
4	Copper, value at New York City.....pounds..	60,480,000	11,491,200
5	Lead, value at New York City.....short tons..	97,825	9,782,500
6	Zinc, value at New York City.....do....	23,239	2,277,432
7	Quicksilver, value at San Francisco.....flasks..	59,926	1,797,780
8	Nickel, value at Philadelphia.....pounds..	233,893	257,282
9	Aluminum, value at Pittsburgh.....do....	.....	.....
10	Antimony, value at San Francisco.....short tons..	50	10,000
11	Platinum (crude), value at San Francisco.....troy ounces..	100	400
12	Total value of metallic products.....	.....	185,649,163
	NONMETALS (SPOT VALUE).		
13	Bituminous coal.....short tons..	38,242,641	53,443,718
14	Pennsylvania anthracite.....long tons..	25,580,189	42,196,678
15	Stone.....	.....	18,356,055
16	Petroleum.....barrels..	26,286,123	24,183,233
17	Lime.....do....	28,000,000	19,000,000
18	Natural gas.....	.....	.....
19	Cement.....barrels..	2,072,943	1,852,707
20	Salt.....do....	5,961,060	4,829,566
21	Phosphate rock.....long tons..	211,377	1,123,823
22	Limestone for iron flux.....do....	4,500,000	3,800,000
23	Mineral waters.....gallons sold..	2,000,000	500,000
24	Zinc white.....short tons..	10,107	763,738
25	Potters' clay.....do....	28,877	200,457
26	Mineral paints.....do....	3,604	135,840
27	Borax.....pounds..	3,692,443	277,233
28	Gypsum.....short tons..	90,000	400,000
29	Grindstones.....	.....	500,000
30	Fibrous talc.....short tons..	4,210	54,730
31	Pyrite.....long tons..	2,000	5,000
32	Soapstone.....short tons..	8,441	66,665
33	Manganese ore.....long tons..	5,761	86,415
34	Asphalt.....short tons..	444	4,440
35	Precious stones.....	.....	100,000
36	Bromine.....pounds..	404,690	114,752
37	Corundum.....short tons..	1,044	29,280
38	Barytes (crude).....do....	20,000	80,000
39	Graphite.....pounds..	.....	49,800
40	Millstones.....	.....	200,000
41	Oilstones, etc.[a].....pounds..	420,000	8,000
42	Marls.....short tons..	1,000,000	500,000
43	Flint.....long tons..	20,000	80,000
44	Fluorspar.....short tons..	4,000	16,000
45	Chromic iron ore.....long tons..	2,288	27,808
46	Infusorial earth.....short tons..	1,833	45,660
47	Feldspar.....long tons..	12,500	60,000
48	Mica.....pounds..	81,669	127,825
49	Cobalt oxide.....do....	7,251	24,000
50	Slate ground as a pigment.....short tons..	1,000	10,000
51	Sulphur.....do....	600	21,000
52	Asbestos.....do....	150	4,312
53	Rutile.....pounds..	100	400
54	Lithographic stone.....short tons..	.....	.....
55	Total value of nonmetallic mineral products.....	.....	173,279,135
56	Total value of metallic products.....	.....	185,649,163
57	Estimated value of mineral products unspecified.....	.....	6,000,000
58	Grand total.....	.....	364,928,298

[a] Prior to 1889 quantity and value are for rough stone quarried; since 1890 they are for finished product.

for the calendar years 1880–1913.

1881		1882		1883		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
4,144,254	$87,029,334	4,623,323	$106,336,429	4,595,510	$91,910,200	1
33,257,800	37,657,500	36,196,900	41,105,900	35,732,800	39,618,400	2
1,678,612	34,700,000	1,572,187	32,500,000	1,451,250	30,000,000	3
71,680,000	12,175,600	91,646,232	16,038,091	117,151,795	18,064,807	4
117,085	11,240,160	132,890	12,624,550	143,957	12,322,719	5
26,800	2,680,000	33,765	3,646,620	36,872	3,311,106	6
60,851	1,764,679	52,732	1,487,042	46,725	1,253,632	7
265,668	292,235	281,616	309,777	58,800	52,920	8
.....	.....	.....	.....	83	875	9
50	10,000	60	12,000	60	12,000	10
100	400	200	600	200	600	11
.....	187,549,908	.....	214,061,009	.....	196,547,259	12
48,179,475	60,224,344	60,861,190	76,076,487	68,531,500	82,237,800	13
28,500,016	64,125,036	31,358,264	70,556,094	34,336,469	77,257,055	14
.....	20,000,000	.....	21,000,000	.....	20,000,000	15
27,661,238	25,448,339	30,510,830	24,065,988	23,449,633	25,790,252	16
30,000,000	20,000,000	31,000,000	21,700,000	32,000,000	19,200,000	17
.....	.....	.....	215,000	.....	475,000	18
2,500,000	2,000,000	3,250,000	3,672,750	4,190,000	4,293,500	19
6,200,000	4,200,000	6,412,373	4,320,140	6,192,231	4,211,042	20
266,734	1,980,259	332,077	1,992,462	378,380	2,270,280	21
6,000,000	4,100,000	3,850,000	2,310,000	3,814,273	1,907,136	22
3,700,000	700,000	5,000,000	800,000	7,529,423	1,119,603	23
10,000	700,000	10,000	700,000	12,000	840,000	24
28,000	200,000	33,600	240,000	35,840	250,000	25
6,000	100,000	7,000	105,000	7,000	84,000	26
4,046,000	304,461	4,236,291	338,903	6,500,000	585,000	27
85,000	350,000	100,000	450,000	90,000	420,000	28
.....	500,000	.....	700,000	.....	600,000	29
5,000	60,000	6,000	75,000	6,000	75,000	30
10,000	60,000	12,000	72,000	25,000	137,500	31
7,000	75,000	6,000	90,000	8,000	150,000	32
4,895	73,425	4,532	67,980	6,155	92,325	33
2,000	8,000	3,000	10,500	3,000	10,500	34
.....	110,000	.....	150,000	.....	207,050	35
300,000	75,000	250,000	75,000	301,100	72,264	36
500	80,000	500	80,000	550	100,000	37
20,000	80,000	20,000	80,000	27,000	108,000	38
400,000	30,000	425,000	34,000	575,000	46,000	39
.....	150,000	.....	200,000	.....	150,000	40
500,000	8,580	600,000	10,000	600,000	10,000	41
1,000,000	500,000	1,080,000	540,000	972,000	486,000	42
25,000	100,000	25,000	100,000	25,000	100,000	43
4,000	16,000	4,000	20,000	4,000	20,000	44
2,000	30,000	2,500	50,000	3,000	60,000	45
1,000	10,000	1,000	8,000	1,000	5,000	46
14,000	70,000	14,000	70,000	14,100	71,112	47
100,000	250,000	100,000	250,000	114,000	285,000	48
8,280	25,000	11,653	32,046	1,096	2,795	49
1,000	10,000	2,000	24,000	2,000	24,000	50
600	21,000	600	21,000	1,000	27,000	51
200	7,000	1,200	36,000	1,000	30,000	52
200	700	500	1,800	550	2,000	53
50	1,000	.....	.....	.....	.....	54
.....	206,783,144	.....	231,340,150	.....	243,812,214	55
.....	187,549,908	.....	214,061,009	.....	196,547,259	56
.....	6,500,000	.....	6,500,000	.....	6,500,000	57
.....	400,833,052	.....	451,901,159	.....	446,859,473	58

Mineral products of the United States for

	Product.	1884	
		Quantity.	Value.
	METALS.		
1	Pig iron, value at Philadelphia.....long tons..	4,097,868	$73,761,624
2	Silver, commercial value.....troy ounces..	37,743,800	41,921,300
3	Gold, coining value.....do....	1,489,950	30,800,000
4	Copper, value at New York City.....pounds..	145,221,934	17,789,687
5	Lead, value at New York City.....short tons..	139,897	10,537,042
6	Zinc, value at New York City.....do....	38,544	3,422,707
7	Quicksilver, value at San Francisco.....flasks..	31,913	936,327
8	Nickel, value at Philadelphia.....pounds..	64,550	48,412
9	Aluminum, value at Pittsburgh.....do....	150	1,350
10	Antimony, value at San Francisco.....short tons..	60	12,000
11	Platinum (crude), value at San Francisco.....troy ounces..	150	450
12	Total value of metallic products.....	.....	179,230,899
	NONMETALS (SPOT VALUE).		
13	Bituminous coal.....short tons..	73,730,539	77,417,066
14	Pennsylvania anthracite.....long tons..	33,175,756	66,351,512
15	Stone.....	.....	19,000,000
16	Petroleum.....barrels..	24,218,438	20,595,966
17	Lime.....do....	37,000,000	18,500,000
18	Natural gas.....	.....	1,460,000
19	Brick clay.....	.....	.....
20	Clay (all other than brick).....short tons..	39,200	270,000
21	Cement.....barrels..	4,000,000	3,720,000
22	Salt.....do....	6,514,937	4,197,734
23	Phosphate rock.....long tons..	431,779	2,374,784
24	Limestone for iron flux.....do....	3,401,930	1,700,965
25	Mineral waters.....gallons sold..	10,215,328	1,459,143
26	Zinc white.....short tons..	13,000	910,000
27	Mineral paints.....do....	7,000	84,000
28	Borax.....pounds..	7,000,000	490,000
29	Gypsum.....short tons..	90,000	390,000
30	Grindstones.....	.....	570,000
31	Fibrous talc.....short tons..	10,000	110,000
32	Pyrite.....long tons..	35,000	175,000
33	Soapstone.....short tons..	10,000	200,000
34	Manganese ore.....long tons..	10,180	122,160
35	Asphalt.....short tons..	3,000	10,500
36	Precious stones.....	.....	222,975
37	Bromine.....pounds..	281,100	67,464
38	Corundum.....short tons..	600	108,000
39	Barytes (crude).....do....	25,000	100,000
40	Graphite.....pounds..	.....	.....
41	Millstones.....	.....	150,000
42	Oilstones, etc.[a].....pounds..	800,000	12,000
43	Marls.....short tons..	875,000	437,500
44	Flint.....long tons..	30,000	120,000
45	Fluorspar.....short tons..	4,000	20,000
46	Chromic iron ore.....long tons..	2,000	35,000
47	Infusorial earth.....short tons..	1,000	5,000
48	Feldspar.....long tons..	10,900	55,112
49	Mica.....pounds..	147,410	368,525
50	Cobalt oxide.....do....	2,000	5,100
51	Slate ground as a pigment.....short tons..	2,000	20,000
52	Sulphur.....do....	500	12,000
53	Asbestos.....do....	1,000	30,000
54	Rutile.....pounds..	600	2,000
55	Lithographic stone.....short tons..	.....	.....
56	Total value of nonmetallic mineral products.....	.....	221,879,506
57	Total value of metallic products.....	.....	179,230,899
58	Estimated value of mineral products unspecified.....	.....	5,000,000
59	Grand total.....	.....	406,110,405

[a] Prior to 1889 quantity and value are for rough stone quarried; since 1890 they are for finished product.

the calendar years 1880–1913—Continued.

1885		1886		1887		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
4,044,425	$64,712,400	5,683,329	$95,195,760	6,417,148	$121,925,800	1
39,909,400	42,503,500	39,694,000	39,482,400	41,721,600	40,887,200	2
1,538,373	31,801,000	1,686,788	34,869,000	1,603,049	33,136,000	3
170,962,607	18,292,999	161,235,381	16,527,651	185,227,331	21,115,916	4
129,412	10,469,431	130,629	12,200,749	145,700	13,113,000	5
40,688	3,539,856	42,641	3,752,408	50,340	4,782,300	6
32,073	979,189	29,981	1,060,000	33,825	1,429,000	7
277,904	159,975	214,992	127,157	205,566	133,200	8
283	2,550	3,000	27,000	18,000	59,000	9
50	10,000	35	7,000	75	15,000	10
250	187	50	100	448	1,838	11
.....	172,491,087	.....	203,249,225	.....	236,598,254	12
64,840,668	82,347,648	73,707,957	78,481,056	87,887,360	98,004,656	13
34,228,548	76,671,948	34,853,077	76,119,120	37,578,747	84,552,181	14
.....	19,000,000	.....	19,000,000	.....	25,000,000	15
21,847,205	19,198,243	28,064,841	19,996,313	28,278,866	18,877,094	16
40,000,000	20,000,000	.....	.....	.....	.....	17
.....	4,857,200	.....	10,012,000	.....	15,817,500	18
.....	.....	.....	6,200,000	.....	7,000,000	19
40,320	275,000	44,800	325,000	48,160	340,000	20
4,150,000	3,492,500	4,500,000	3,990,000	6,692,744	5,674,377	21
7,038,653	4,825,345	7,707,081	4,736,585	7,831,962	4,093,846	22
437,856	2,846,064	430,549	1,872,936	480,558	1,836,818	23
3,356,956	1,678,478	4,717,163	2,830,297	5,377,000	3,226,200	24
9,148,401	1,312,845	8,950,317	1,284,070	8,259,609	1,261,463	25
15,000	1,050,000	18,000	1,440,000	18,000	1,440,000	26
3,950	43,575	18,800	315,000	22,000	330,000	27
8,000,000	480,000	9,778,290	488,915	11,000,000	550,000	28
90,405	405,000	95,250	428,625	95,000	425,000	29
.....	500,000	.....	250,000	.....	224,400	30
10,000	110,000	12,000	125,000	15,000	160,000	31
49,000	220,500	55,000	220,000	52,000	210,000	32
10,000	200,000	12,000	225,000	12,000	225,000	33
23,258	190,281	30,193	277,636	34,524	333,844	34
3,000	10,500	3,500	14,000	4,000	16,000	35
.....	209,900	.....	119,056	.....	163,600	36
310,000	89,900	428,334	141,350	199,087	61,717	37
600	108,000	645	116,190	600	108,000	38
15,000	75,000	10,000	50,000	15,000	75,000	39
327,883	26,231	415,525	33,242	416,000	34,000	40
.....	100,000	.....	140,000	.....	100,000	41
1,000,000	15,000	1,160,000	15,000	1,200,000	16,000	42
875,000	437,500	800,000	400,000	600,000	300,000	43
30,000	120,000	30,000	120,000	32,000	128,000	44
5,000	22,500	5,000	22,000	5,000	20,000	45
2,700	40,000	2,000	30,000	3,000	40,000	46
1,000	5,000	1,200	6,000	3,000	15,000	47
13,600	68,000	14,090	74,500	10,200	61,200	48
92,000	161,000	40,000	70,000	70,000	142,250	49
68,723	65,373	35,000	36,878	18,340	18,774	50
1,975	24,687	.....	.....	.....	.....	51
715	17,875	2,500	75,000	3,000	100,000	52
300	9,000	200	6,000	150	4,500	53
600	2,000	600	2,000	1,000	3,000	54
.....	.....	.....	.....	.....	.....	55
.....	241,312,093	.....	230,088,769	.....	270,989,420	56
.....	172,491,087	.....	203,249,225	.....	236,598,254	57
.....	5,000,000	.....	800,000	.....	800,000	58
.....	418,803,180	.....	434,137,994	.....	508,387,674	59

Mineral products of the United States for

	Product.	1888	
		Quantity.	Value.
	METALS.		
1	Pig iron, value at Philadelphia.....long tons..	6,489,738	$107,000,000
2	Silver, commercial value.....troy ounces..	45,792,700	43,045,100
3	Gold, coining value.....do....	1,604,478	33,167,500
4	Copper, value at New York City.....pounds..	231,270,622	33,833,954
5	Lead, value at New York City.....short tons..	151,919	13,399,256
6	Zinc, value at New York City.....do....	55,903	5,500,855
7	Quicksilver, value at San Francisco.....flasks..	33,250	1,413,125
8	Aluminum, value at Pittsburgh.....pounds..	19,000	65,000
9	Antimony, value at San Francisco.....short tons..	100	20,000
10	Nickel, value at Philadelphia.....pounds..	204,328	127,632
11	Tin.....do....	.....	.....
12	Platinum (crude), value at San Francisco.....troy ounces..	500	2,000
13	Total value of metallic products.....	.....	237,574,422
	NONMETALS (SPOT VALUE).		
14	Bituminous coal.....short tons..	102,039,838	101,860,529
15	Pennsylvania anthracite.....long tons..	41,624,611	89,020,483
16	Stone.....	.....	25,500,000
17	Petroleum.....barrels..	27,612,025	17,947,620
18	Natural gas.....	.....	22,629,875
19	Brick clay.....	.....	7,500,000
20	Clay (all other than brick).....short tons..	41,160	300,000
21	Cement.....barrels..	6,503,295	5,021,139
22	Mineral waters.....gallons sold..	9,578,648	1,679,302
23	Phosphate rock.....long tons..	448,567	2,018,552
24	Salt.....barrels..	8,055,881	4,374,203
25	Limestone for iron flux.....long tons..	5,438,000	2,719,000
26	Zinc white.....short tons..	20,000	1,600,000
27	Gypsum.....do....	110,000	550,000
28	Borax.....pounds..	7,589,000	455,340
29	Mineral paints.....short tons..	26,500	405,000
30	Grindstones.....	.....	281,800
31	Fibrous tale.....short tons..	20,000	210,000
32	Asphalt.....do....	53,800	331,500
33	Soapstone.....do....	15,000	250,000
34	Precious stones.....	.....	139,850
35	Pyrite.....long tons..	54,331	167,658
36	Corundum.....short tons..	589	91,620
37	Oilstones, etc.a.....pounds..	1,500,000	18,000
38	Mica.....do....	48,000	70,000
39	Barytes (crude).....short tons..	20,000	110,000
40	Bromine.....pounds..	307,386	95,290
41	Fluorspar.....short tons..	6,000	30,000
42	Feldspar.....long tons..	8,700	50,000
43	Manganese ore.....do....	29,198	279,571
44	Flint.....do....	30,000	127,500
45	Graphite.....pounds..	400,000	33,000
46	Bauxite.....long tons..	.....	.....
47	Sulphur.....short tons..	.....	.....
48	Marls.....do....	300,000	150,000
49	Infusorial earth.....do....	1,500	7,500
50	Millstones.....	.....	81,000
51	Chromic iron ore.....long tons..	1,500	20,000
52	Cobalt oxide.....pounds..	8,491	15,782
53	Magnesite.....short tons..	.....	.....
54	Asbestos.....do....	100	3,000
55	Rutile.....pounds..	1,000	3,000
56	Ozokerite (refined).....do....	43,500	3,300
57	Total value of nonmetallic mineral products.....	.....	286,150,114
58	Total value of metallic products.....	.....	237,574,422
59	Estimated value of mineral products unspecified.....	.....	900,000
60	Grand total.....	.....	524,624,536

a Prior to 1889 quantity and value are for rough stone quarried; since 1890 they are for finished product.

the calendar years 1880–1913—Continued.

1889		1890		1891		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
7,603,642	$120,000,000	9,202,703	$151,200,410	8,279,870	$128,387,985	1
50,094,500	46,838,400	54,516,300	57,242,100	58,330,000	57,630,000	2
1,594,775	32,967,000	1,588,877	32,845,000	1,604,840	33,175,000	3
231,246,214	26,907,809	265,115,133	30,848,797	295,812,076	38,455,300	4
156,397	13,794,235	143,630	12,668,166	178,554	15,534,198	5
58,860	5,791,824	63,683	6,266,407	80,873	8,033,700	6
26,484	1,190,500	22,926	1,203,615	22,904	1,036,386	7
47,468	97,335	61,281	61,281	150,000	100,000	8
115	28,000	938	177,508	1,289	217,957	9
252,663	151,598	223,488	134,093	118,498	71,099	10
.....	.....	.....	.....	125,289	25,058	11
500	2,000	600	2,500	100	500	12
.....	247,768,701	.....	292,649,877	.....	282,617,183	13
95,685,543	94,504,745	111,320,016	110,420,801	117,901,237	117,188,400	14
40,714,721	65,879,514	41,489,858	66,383,772	45,236,992	73,944,735	15
.....	42,809,706	.....	47,000,000	.....	47,294,746	16
35,163,513	26,963,340	45,822,672	35,365,105	54,291,980	30,526,553	17
.....	21,097,099	.....	18,792,725	.....	15,500,084	18
.....	8,000,000	.....	8,500,000	.....	9,000,000	19
329,665	635,578	392,000	756,000	448,000	900,000	20
7,000,000	5,000,000	8,000,000	6,000,000	8,222,792	6,680,951	21
12,780,471	1,748,458	13,907,418	2,600,750	18,392,732	2,996,259	22
550,245	2,937,776	510,499	3,213,795	587,988	3,651,150	23
8,005,565	4,195,412	8,776,991	4,752,286	9,987,945	4,716,121	24
6,318,000	3,159,000	5,521,622	2,760,811	5,000,000	2,300,000	25
16,970	1,357,600	.....	1,600,000	23,700	1,600,000	26
267,769	764,118	182,995	574,523	208,126	628,051	27
8,000,000	500,000	9,500,000	617,500	13,380,000	869,700	28
34,307	483,766	47,732	681,992	49,652	678,478	29
.....	439,587	.....	450,000	.....	476,113	30
23,746	244,170	41,354	389,196	53,054	493,068	31
51,735	171,537	40,841	190,416	45,054	242,264	32
12,715	231,708	13,670	252,309	16,514	243,981	33
.....	188,807	.....	118,833	.....	235,300	34
93,705	202,119	99,854	273,745	106,536	338,880	35
2,245	105,565	1,970	89,395	2,265	90,230	36
5,982,000	32,980	.....	69,909	1,375,000	150,000	37
49,500	50,000	60,000	75,000	75,000	100,000	38
19,161	106,313	21,911	86,505	31,069	118,363	39
418,891	125,667	387,847	104,719	343,000	54,880	40
9,500	45,835	8,250	55,328	10,044	78,330	41
6,970	39,370	8,000	45,200	10,000	50,000	42
24,197	240,559	25,684	219,050	23,416	239,129	43
21,113	89,730	13,000	57,400	15,000	60,000	44
.....	72,662	.....	77,500	.....	110,000	45
728	2,366	1,844	6,012	3,593	11,675	46
1,150	7,850	.....	.....	1,200	39,600	47
139,522	63,956	153,620	69,880	135,000	67,500	48
3,466	23,372	2,532	50,240	.....	21,988	49
.....	35,155	.....	23,720	.....	16,587	50
2,000	30,000	3,599	53,985	1,372	20,580	51
13,955	31,092	6,788	16,291	7,200	18,000	52
.....	.....	.....	.....	439	4,390	53
30	1,800	71	4,560	66	3,390	54
1,000	3,000	400	1,000	300	800	55
50,000	2,500	350,000	26,250	50,000	7,000	56
.....	282,623,812	.....	312,826,503	.....	321,767,846	57
.....	247,768,701	.....	292,649,877	.....	282,617,183	58
.....	1,000,000	.....	1,000,000	.....	1,000,000	59
.....	531,392,513	.....	606,476,380	.....	605,385,029	60

Mineral products of the United States for

	Product.		1892	
			Quantity.	Value.
	METALS.			
1	Pig iron, spot value	long tons	9,157,000	$131,161,039
2	Silver, commercial value	troy ounces	63,500,000	55,662,500
3	Gold, coining value	do	1,597,098	33,015,000
4	Copper, value at New York City	pounds	352,971,744	37,977,142
5	Lead, value at New York City	short tons	173,654	13,892,320
6	Zinc, value at New York City	do	87,260	8,027,920
7	Quicksilver, value at San Francisco	flasks	27,993	1,245,689
8	Aluminum, value at Pittsburgh	pounds	259,885	172,824
9	Antimony, value at San Francisco	short tons	1,790	276,416
10	Nickel, value at Philadelphia	pounds	92,252	50,739
11	Tin	do	162,000	32,400
12	Platinum, value (crude) at San Francisco	troy ounces	80	550
13	Total value of metallic products			281,514,539
	NONMETALS (SPOT VALUE).			
14	Bituminous coal	short tons	126,856,567	125,124,381
15	Pennsylvania anthracite	long tons	46,850,450	82,442,000
16	Natural gas			14,870,714
17	Petroleum	barrels	50,509,136	26,034,196
18	Brick clay			9,000,000
19	Cement	barrels	8,758,621	7,152,750
20	Stone			48,706,625
21	Corundum and emery	short tons	1,771	181,300
22	Crystalline quartz	do		
23	Garnet for abrasive purposes	do		
24	Grindstones			272,244
25	Infusorial earth and tripoli	short tons		43,655
26	Millstones			23,417
27	Oilstones, etc			146,730
28	Borax	pounds	13,500,000	900,000
29	Bromine	do	379,480	64,502
30	Fluorspar	short tons	12,250	89,000
31	Gypsum	do	256,259	695,492
32	Marls	do	125,000	65,000
33	Phosphate rock	long tons	681,571	3,296,227
34	Pyrite	do	109,788	305,191
35	Salt	barrels	11,698,890	5,654,915
36	Sulphur	short tons	2,688	80,640
37	Barytes (crude)	do	32,108	130,025
38	Cobalt oxide	pounds	7,869	15,738
39	Mineral paints	short tons	51,704	767,766
40	Zinc white	do	27,500	2,200,000
41	Asbestos	do	104	6,416
42	Asphalt	do	87,680	445,375
43	Bauxite	long tons	10,518	34,183
44	Chromic iron ore	do	1,500	25,000
45	Clay (all other than brick)	short tons	470,400	1,000,000
46	Feldspar	do	16,800	75,000
47	Fibrous talc	do	41,925	472,485
48	Flint	do	22,400	80,000
49	Fuller's earth	do		
50	Graphite	pounds		104,000
51	Limestone for iron flux	long tons	5,172,114	3,620,480
52	Magnesite	short tons	1,004	10,040
53	Manganese ore	long tons	13,613	129,586
54	Mica	pounds	75,000	100,000
55	Mineral waters	gallons sold	21,876,604	4,905,970
56	Monazite	pounds		
57	Ozokerite (refined)	do	60,000	8,000
58	Precious stones			312,050
59	Pumice stone	short tons		
60	Rutile	pounds	100	300
61	Soapstone	short tons	23,908	437,449
62	Total value of nonmetallic mineral products			340,028,842
63	Total value of metallic products			281,514,539
64	Estimated value of mineral products unspecified			1,000,000
65	Grand total			622,543,381

[a] Including copper made from imported pyrites.

the calendar years 1880–1913—Continued.

1893		1894		1895		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
7,124,502	$84,810,426	6,657,388	$65,007,247	9,446,308	$105,198,550	1
60,000,000	46,800,000	49,500,000	31,422,100	55,727,000	36,445,500	2
1,739,323	35,955,000	1,910,813	39,500,000	2,254,760	46,610,000	3
339,785,972	32,054,601	364,866,808	33,141,142	[a] 385,913,404	38,012,470	4
163,982	11,839,590	159,331	9,942,254	170,000	11,220,000	5
78,832	6,306,560	75,328	5,288,026	89,686	6,278,020	6
30,164	1,108,527	30,416	934,000	36,104	1,337,131	7
339,629	2 6,903	550,000	316,250	920,000	464,600	8
1,503	270,540	1,387	249,706	2,013	304,169	9
49,399	22,197	9,616	3,269	10,302	3,091	10
8,938	1,788	.....	.....	.....	.....	11
75	517	100	600	150	900	12
.....	219,436,649	.....	185,804,594	.....	245,874,431	13
128,385,231	122,751,618	118,820,405	107,653,501	135,118,193	115,779,771	14
48,185,306	85,687,078	46,358,144	78,488,063	51,785,122	82,019,272	15
.....	14,346,250	.....	13,954,400	.....	13,006,650	16
48,412,666	28,932,326	49,344,516	35,522,095	52,892,276	57,632,296	17
.....	9,000,000	.....	[b] 64,655,388	.....	[b] 65,409,806	18
8,002,467	6,262,841	8,362,245	5,030,081	8,731,401	5,482,254	19
.....	33,885,573	.....	36,534,788	.....	33,319,131	20
1,713	142,325	1,495	95,936	2,102	106,256	21
.....	.....	6,024	18,054	9,000	27,000	22
.....	.....	.....	.....	3,325	95,050	23
.....	338,787	.....	223,214	.....	205,768	24
.....	22,582	2,584	11,718	4,954	20,514	25
.....	16,645	.....	13,887	.....	22,542	26
.....	135,173	.....	136,873	.....	155,881	27
8,699,000	652,425	14,680,130	974,445	11,918,000	595,900	28
348,399	104,520	379,444	102,450	517,421	134,343	29
12,400	84,000	7,500	47,500	4,000	24,000	30
253,615	696,615	239,312	761,719	265,503	797,447	31
75,000	40,000	75,000	40,000	60,000	30,000	32
941,368	4,136,070	996,949	3,479,547	1,038,551	3,606,094	33
75,777	256,552	105,940	363,134	99,549	322,845	34
11,816,772	4,054,668	12,967,417	4,739,285	13,669,649	4,423,084	35
1,200	42,000	500	20,000	1,800	42,000	36
28,970	88,506	23,335	86,983	21,529	68,321	37
8,422	10,346	6,763	10,145	14,458	20,675	38
37,724	530,384	41,926	498,093	50,695	621,552	39
24,059	1,804,420	19,987	1,399,090	20,710	1,449,700	40
50	2,500	325	4,463	795	13,525	41
47,779	372,232	60,570	353,400	68,163	348,281	42
9,079	29,507	11,066	35,818	17,069	44,000	43
1,450	21,750	3,680	53,231	1,740	16,795	44
448,000	900,000	.....	.....	.....	.....	45
20,578	68,307	19,264	167,000	8,523	30,000	46
35,861	403,436	39,906	435,000	39,240	370,897	47
33,231	63,792	42,560	319,200	13,747	21,038	48
.....	.....	.....	.....	6,900	41,400	49
843,103	63,232	918,000	64,010	.....	52,582	50
3,958,055	2,374,833	3,698,550	1,849,275	5,247,949	2,623,974	51
704	7,040	1,440	10,240	2,220	17,000	52
7,718	66,614	6,308	53,635	9,547	71,769	53
66,971	88,929	.....	52,388	.....	55,831	54
23,544,495	4,246,734	21,569,608	3,741,846	21,463,543	4,254,237	55
130,000	7,600	546,855	36,193	1,573,000	137,150	56
.....	.....	.....	.....	.....	.....	57
.....	264,041	.....	132,250	.....	113,621	58
.....	.....	.....	.....	.....	.....	59
.....	.....	150	450	100	350	60
21,071	255,067	23,144	401,325	21,495	266,495	61
.....	323,257,318	.....	362,570,173	.....	393,897,097	62
.....	219,436,649	.....	185,804,594	.....	245,874,431	63
.....	1,000,000	.....	1,000,000	.....	1,000,000	64
.....	543,693,967	.....	549,374,767	.....	640,771,528	65

[b] Clay products.

Mineral products of the United States for

	Product.		1896	
			Quantity.	Value.
	METALS.			
1	Pig iron, spot value	long tons.	8,623,127	$90,250,000
2	Silver, commercial value	troy ounces.	58,834,800	39,654,600
3	Gold, coining value	do.	2,568,132	53,088,000
4	Copper, value at New York City	pounds.	460,061,430	49,456,603
5	Lead, value at New York City	short tons.	188,000	10,528,000
6	Zinc, value at New York City	do.	81,499	6,519,920
7	Quicksilver, value at San Francisco	flasks.	30,765	1,075,449
8	Aluminum, value at Pittsburgh	pounds.	1,300,000	520,000
9	Antimony, value at San Francisco	short tons.	2,478	347,539
10	Nickel, value at Philadelphia	pounds.	17,170	4,464
11	Tin	do.	.....	.....
12	Platinum, value (crude) at New York City	troy ounces.	163	944
13	Total value of metallic products		.....	251,445,519
	NONMETALS (SPOT VALUE).			
14	Bituminous coal	short tons.	137,640,276	114,891,515
15	Pennsylvania anthracite	long tons.	48,523,287	81,748,651
16	Natural gas		.....	13,002,512
17	Petroleum	barrels.	60,960,361	58,518,709
18	Clay products		.....	63,110,408
19	Cement	barrels.	9,513,473	6,473,213
20	Lime		.....	6,327,900
21	Slate		.....	2,746,205
22	Stone		.....	23,965,229
23	Corundum and emery	short tons.	2,120	113,246
24	Crystalline quartz	do.	6,000	18,000
25	Garnet for abrasive purposes	do.	2,686	68,877
26	Grindstones		.....	326,826
27	Infusorial earth and tripoli	short tons.	3,846	26,792
28	Millstones		.....	22,567
29	Oilstones, etc		.....	127,098
30	Borax	pounds.	13,508,000	675,400
31	Bromine	do.	546,580	144,501
32	Fluorspar	short tons.	6,500	52,000
33	Gypsum	do.	224,254	573,344
34	Marls	do.	60,000	30,000
35	Phosphate rock	long tons.	930,779	2,803,372
36	Pyrite	do.	115,483	320,163
37	Salt	barrels.	13,850,726	4,040,839
38	Sulphur	short tons.	5,260	87,200
39	Barytes (crude)	do.	17,068	46,513
40	Cobalt oxide	pounds.	10,700	15,301
41	Mineral paints	short tons.	43,894	459,089
42	Zinc white	do.	20,000	1,400,000
43	Asbestos	do.	504	6,100
44	Asphalt	do.	80,503	577,563
45	Bauxite	long tons.	18,364	47,338
46	Chromic iron ore	do.	786	6,667
47	Feldspar	short tons.	10,203	35,200
48	Fibrous talc	do.	46,089	399,443
49	Fuller's earth	do.	9,872	59,360
50	Graphite (crystalline)	pounds.	535,858	48,460
51	Graphite (amorphous)	short tons.	760	
52	Magnesite	do.	1,500	11,000
53	Manganese ore	long tons.	10,088	90,727
54	Mica (sheet)	pounds.	49,156	65,441
55	Mica (scrap)	short tons.	222	1,750
56	Mineral waters	gallons sold.	25,795,312	4,136,192
57	Monazite	pounds.	30,000	1,500
58	Ozokerite (refined)	do.	.....	.....
59	Precious stones		.....	97,850
60	Pumice stone	short tons.	.....	.....
61	Quartz (flint)	do.	12,458	24,226
62	Rutile	pounds.	100	350
63	Soapstone	short tons.	22,183	354,065
64	Total value of nonmetallic mineral products		.....	388,098,702
65	Total value of metallic products		.....	251,445,519
66	Estimated value of mineral products unspecified		.....	1,000,000
67	Grand total		.....	640,544,221

the calendar years 1880–1913—Continued.

1897		1898		1899		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
9,652,680	$95,122,299	11,773,934	$116,557,000	13,620,703	$245,172,654	1
53,860,000	32,316,000	54,438,000	32,118,400	54,764,500	32,858,700	2
2,774,935	57,363,000	3,118,398	64,463,000	3,437,210	71,053,400	3
494,078,274	54,080,180	526,512,987	61,865,276	568,666,921	101,222,712	4
212,000	14,885,728	222,000	16,650,000	210,500	18,945,000	5
99,980	8,498,300	115,399	10,385,910	129,051	14,840,865	6
26,648	293,445	31,092	1,188,627	30,454	1,452,745	7
4,000,000	1,500,000	5,200,000	1,716,000	6,500,000	1,716,000	8
3,061	442,300	3,238	532,101	2,861	559,189	9
23,707	7,823	11,145	3,956	22,541	8,566	10
						11
150	900	225	1,913	300	1,800	12
	265,209,975		305,482,183		487,831,631	13
147,617,519	119,595,224	166,593,623	132,608,713	193,323,187	167,952,104	14
46,974,714	79,301,954	47,663,076	75,414,537	53,944,647	88,142,130	15
	13,826,422		15,296,813		20,074,873	16
60,475,516	40,874,072	55,364,233	44,193,359	57,070,850	64,603,904	17
	62,359,991		74,487,680		95,797,370	18
10,989,463	8,178,283	12,111,208	9,859,501	15,520,445	12,889,142	19
	6,390,487		6,886,549		6,983,067	20
	3,524,614		3,723,540		3,962,733	21
	26,876,671		28,635,175		35,244,717	22
2,165	106,574	4,064	275,064	4,900	150,600	23
7,500	22,500	8,312	23,990	13,600	39,000	24
2,554	80,853	2,967	86,850	2,765	98,325	25
	368,058		489,769		675,586	26
3,833	22,835	2,733	16,691	4,334	37,032	27
	25,932		25,934		28,115	28
	149,970		180,486		208,283	29
16,000,000	1,080,000	16,000,000	1,120,000	40,714,000	1,139,882	30
487,149	129,094	486,979	126,614	433,004	108,251	31
5,062	37,159	7,675	63,050	15,900	96,650	32
288,982	755,864	291,638	755,280	486,235	1,287,080	33
60,000	30,000	60,000	30,000	60,000	30,000	34
1,029,345	2,673,202	1,308,885	3,453,460	1,515,702	5,084,076	35
143,201	391,541	193,364	593,801	174,734	543,249	36
15,973,202	4,920,020	17,612,634	6,212,554	19,708,614	6,867,467	37
2,275	45,590	1,200	32,960	4,830	107,500	38
26,042	58,295	31,306	108,339	41,894	139,528	39
19,520	31,232	6,247	9,371	10,230	18,512	40
47,308	501,029	48,479	534,345	51,020	517,328	41
25,000	1,750,000	33,000	2,310,000	40,146	3,211,680	42
580	6,450	605	10,300	681	11,740	43
75,945	664,632	76,337	675,649	75,085	553,904	44
20,590	57,652	25,149	75,437	35,280	125,593	45
						46
12,516	43,100	13,440	32,395	24,202	211,545	47
57,099	396,936	54,356	411,430	54,655	438,150	48
17,113	112,272	14,860	106,500	12,381	79,644	49
1,361,706	65,730	2,360,000	75,200	2,900,732	167,106	50
1,070		890		2,324		51
1,143	13,671	1,263	19,075	1,280	18,480	52
11,108	95,505	15,957	129,185	9,935	82,278	53
82,676	80,774	129,520	103,534	108,570	70,587	54
740	14,452	3,999	27,564	1,505	50,878	55
23,255,911	4,599,106	28,853,464	8,051,833	39,562,136	6,948,030	56
44,000	1,980	250,776	13,542	350,000	20,000	57
						58
	130,675		160,920		185,770	59
158		600	13,200	400	10,000	60
13,466	26,227	21,425	42,670	29,852	180,345	61
100	350	140	700	230	1,030	62
21,923	365,629	22,231	287,112	24,765	330,805	63
	380,782,607		417,790,671		525,524,074	64
	265,209,975		305,482,183		487,831,631	65
	1,000,000		1,000,000		1,000,000	66
	646,992,582		724,272,854		1,014,355,705	67

Mineral products of the United States for

	Product.	1900	
		Quantity.	Value.
	METALS.		
1	Pig iron, value at Philadelphia....long tons..	13,789,242	$259,944,000
2	Silver, commercial value....troy ounces..	57,647,000	35,741,100
3	Gold, coining value....do....	3,829,897	79,171,000
4	Copper, value at New York City....pounds..	606,117,166	98,494,039
5	Lead, value at New York City....short tons..	270,824	23,561,688
6	Zinc, value at New York City....do....	123,886	10,654,196
7	Quicksilver, value at San Francisco....flasks..	28,317	1,302,586
8	Aluminum, value at Pittsburgh....pounds..	7,150,000	1,920,000
9	Antimony, value at San Francisco....short tons..	4,226	837,896
10	Nickel, value at Philadelphia....pounds..	9,715	3,886
11	Tin....do....	(a)	.....
12	Platinum, value (crude) at New York City....troy ounces..	400	2,500
13	Total value of metallic products....	.....	511,632,891
	NONMETALS (SPOT VALUE).		
14	Bituminous coal....short tons..	212,316,112	220,930,313
15	Pennsylvania anthracite....long tons..	51,221,353	85,757,851
16	Natural gas....	.....	23,698,674
17	Petroleum....barrels..	63,620,529	75,989,313
18	Clay products....	.....	96,212,345
19	Cement....barrels..	17,231,150	13,283,581
20	Lime....	.....	6,797,496
21	Sand-lime brick....	.....	.....
22	Slate....	.....	4,240,466
23	Stone....	.....	36,970,777
24	Corundum and emery....short tons..	4,305	102,715
25	Crystalline quartz....do....	14,461	40,705
26	Garnet for abrasive purposes....do....	3,185	123,475
27	Grindstones....	.....	710,026
28	Infusorial earth and tripoli....short tons..	3,615	24,207
29	Millstones....	.....	32,858
30	Oilstones, etc....	.....	174,087
31	Arsenious oxide....pounds..	.....	.....
32	Borax....short tons..	b 1,602 c 24,235	170,036 848,215
33	Bromine....pounds..	521,444	140,790
34	Fluorspar....short tons..	18,450	94,500
35	Gypsum....do....	594,462	1,627,203
36	Lithium....do....	520	.....
37	Marls....do....	60,000	30,000
38	Phosphate rock....long tons..	1,491,216	5,359,248
39	Pyrite....do....	204,615	749,991
40	Sulphur....short tons..	3,525	88,100
41	Salt....barrels..	20,869,342	6,944,603
42	Barytes (crude)....short tons..	67,680	188,089
43	Cobalt oxide....pounds..	6,471	11,648
44	Mineral paints....short tons..	57,426	644,089
45	Zinc white....do....	48,840	3,667,210
46	Asbestos....do....	1,054	16,310
47	Asphalt....do....	54,389	415,958
48	Bauxite....long tons..	23,184	89,676
49	Chromic iron ore....do....	140	1,400
50	Feldspar....short tons..	24,821	180,971
51	Fibrous talc....do....	63,500	499,500
52	Fuller's earth....do....	9,698	67,535
53	Glass sand....do....	.....	.....
54	Graphite (crystalline)....pounds..	5,507,855	197,579
55	Graphite (amorphous)....short tons..	611	
56	Magnesite....do....	2,252	19,333
57	Manganese ore....long tons..	11,771	100,289
58	Mica (sheet)....pounds..	456,283	92,758
59	Mica (scrap)....short tons..	5,497	55,202
60	Mineral waters....gallons sold..	47,558,784	6,245,172
61	Monazite and zircon....pounds..	908,000	48,805
62	Precious stones....	.....	233,170
63	Pumice stone....short tons..	.....	.....
64	Quartz (flint)....do....	32,495	86,351
65	Rutile....pounds..	300	1,300
66	Talc and soapstone....short tons..	27,943	383,541
67	Tungsten....do....	46	11,040
68	Uranium and vanadium....do....	.....	.....
69	Total value of nonmetallic mineral products....	.....	594,398,501
70	Total value of metallic products....	.....	511,632,891
71	Estimated value of mineral products unspecified....	.....	1,000,000
72	Grand total....	.....	1,107,031,392

a No metallic tin; about 20 tons of high-grade concentrates shipped to England from South Carolina,

the calendar years 1880–1913—Continued.

1901		1902		1903		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
15,878,354.	$242,174,000	17,821,307	$372,775,000	18,009,252	$344,350,000	1
55,214,000	33,128,400	55,500,000	29,415,000	54,300,000	29,322,000	2
3,805,500	78,666,700	3,870,000	80,000,000	3,560,000	73,591,700	3
602,072,519	87,300,515	659,508,644	76,568,954	698,044,517	91,506,006	4
270,700	23,280,200	270,000	22,140,000	282,000	23,520,000	5
140,822	11,265,760	156,927	14,625,596	159,219	16,717,995	6
29,727	1,382,305	34,291	1,467,848	35,620	1,544,934	7
7,150,000	2,238,000	7,300,000	2,284,590	7,500,000	2,284,900	8
2,639	539,902	3,561	634,506	3,128	548,433	9
6,700	3,551	5,748	2,701	114,200	45,900	10
.....	.....	.....	.....	(*a*)	.....	11
1,408	27,526	94	1,814	110	2,080	12
.....	480,006,859	.....	599,916,009	.....	583,433,948	13
225,828,149	236,422,049	260,216,844	290,858,483	282,749,348	351,687,933	14
60,242,560	112,504,020	36,940,710	76,173,586	66,613,454	152,036,448	15
.....	27,066,077	.....	30,867,863	.....	35,807,860	16
69,389,194	66,417,335	88,766,916	71,178,910	100,461,337	94,694,050	17
.....	110,211,587	.....	122,169,531	.....	131,062,421	18
20,068,737	15,786,789	25,753,504	25,366,380	29,899,140	31,931,341	19
.....	8,204,054	.....	9,335,618	.....	9,255,882	20
.....	.....	.....	.....	.....	155,040	21
.....	4,787,525	.....	5,696,051	.....	6,256,885	22
.....	47,284,183	.....	54,798,682	.....	57,433,141	23
4,305	146,040	4,251	104,605	2,542	64,102	24
14,050	41,500	15,104	84,335	8,938	76,908	25
4,444	158,100	3,926	132,820	3,950	132,500	26
.....	580,703	.....	667,431	.....	721,446	27
4,020	52,950	5,665	53,244	9,219	76,273	28
.....	57,179	.....	59,808	.....	52,552	29
.....	158,300	.....	221,762	.....	366,857	30
600,000	18,000	2,706,000	81,180	1,222,000	36,691	31
b 5,344	697,307	*b* 17,404	2,447,614	*c* 34,430	661,400	32
c 17,887	314,811	*c* 2,600	91,000			
552,043	154,572	513,893	128,472	598,500	167,580	33
19,586	113,803	48,018	271,832	42,523	213,617	34
633,791	1,506,641	816,478	2,089,341	1,041,704	2,792,943	35
1,750	43,200	1,245	25,750	1,155	23,425	36
99,880	124,880	12,439	12,741	34,211	22,521	37
1,483,723	5,316,403	1,490,314	4,693,444	1,581,576	5,319,294	38
241,691	1,257,879	207,874	947,089	*d* 233,127	1,109,818	39
(*d*)	(*d*)	(*d*)	(*d*)			40
20,566,661	6,617,449	23,849,231	5,668,636	18,968,089	5,286,988	41
49,070	157,844	61,668	203,154	50,397	152,150	42
13,360	24,048	3,730	6,714	120,000	228,000	43
52,209	636,145	60,191	745,227	56,262	500,922	44
46,500	3,720,000	52,645	4,016,499	62,962	4,801,718	45
747	13,498	1,005	16,200	887	16,760	46
63,134	555,335	105,458	765,048	101,255	1,005,446	47
18,905	79,914	27,322	120,366	48,087	171,306	48
368	5,790	315	4,567	150	2,250	49
34,741	220,422	45,287	250,424	41,891	256,733	50
69,200	483,600	71,100	615,350	60,230	421,600	51
14,112	96,835	11,492	98,144	20,693	190,277	52
.....	.....	943,135	807,797	823,044	855,828	53
3,967,612	167,714	3,936,824	182,108	4,538,155	225,554	54
809		4,739		16,591		55
3,500	10,500	2,830	8,490	3,744	10,595	56
11,995	116,722	7,477	60,911	2,825	25,335	57
360,060	98,859	373,266	83,843	619,600	118,088	58
2,171	19,719	1,400	35,006	1,659	25,040	59
54,733,661	7,443,904	63,174,552	8,634,179	40,107,147	6,788,426	60
748,736	59,262	802,000	64,160	865,000	65,200	61
.....	289,050	.....	328,450	.....	307,900	62
.....	.....	700	2,750	885	2,665	63
34,420	149,297	36,365	144,209	55,233	156,947	64
44,250	5,710	(*e*)	.....	.....	.....	65
28,643	424,888	26,854	525,157	26,671	418,460	66
179	27,720	184	34,040	292	43,639	67
375	.....	3,810	48,125	30	5,625	68
.....	660,850,112	.....	722,027,126	.....	905,242,380	69
.....	480,006,859	.....	599,916,009	.....	583 433,948	70
.....	1,000,000	.....	1,000,000	.....	1,000,000	71
.....	1,141,856,971	.....	1,322,943,135	.....	1,489,676,328	72

b Refined. *c* Crude. *d* Included under pyrite. *e* Included under estimated unspecified products.

Mineral products of the United States for the calendar years 1880–1913—Continued.

Product.	1904		1905	
	Quantity.	Value.	Quantity.	Value.
METALS.				
Pig iron (spot value)....long tons..	16,497,033	$233,025,000	22,992,380	$382,450,000
Silver, commercial value....troy ounces..	57,682,800	33,456,000	56,101,600	34,221,976
Gold, coining value....do....	3,892,480	80,464,700	4,265,742	88,180,700
Copper, value at New York City....pounds..	812,537,267	105,629,845	888,784,267	137,761,561
Lead, value at New York City....short tons..	307,000	26,402,000	302,000	28,690,000
Zinc, value at New York City....do....	186,702	18,670,200	203,849	24,054,182
Quicksilver, value at San Francisco....flasks..	34,570	1,503,795	30,451	1,103,120
Aluminum, value at Pittsburgh....pounds..	8,600,000	2,477,000	11,347,000	3,246,300
Antimony, value, San Francisco...short tons..	3,057	505,524	3,240	705,787
Nickel, value at Philadelphia....pounds..	24,000	11,400	.....	.....
Tin....do....	.....	.....	None.	.....
Platinum, value at New York City, troy ounces....	200	4,160	318	5,320
Total value of metallic products....	.....	502,149,624	.....	700,418,946
NONMETALS (SPOT VALUE).				
Bituminous coal....short tons..	278,659,689	305,397,001	315,062,785	334,658,294
Pennsylvania anthracite....long tons..	65,318,490	138,974,020	69,339,152	141,879,000
Natural gas....	.....	38,496,700	.....	41,562,855
Petroleum....barrels..	117,080,960	101,175,455	134,717,580	84,157,399
Clay products....	.....	131,023,248	.....	149,697,188
Cement....barrels..	31,675,257	26,031,920	40,102,308	35,931,533
Lime....short tons..	2,707,809	9,951,456	2,984,100	10,941,680
Sand-lime brick....	.....	463,128	.....	972,064
Slate....	.....	5,617,195	.....	5,496,207
Stone....	.....	58,765,715	.....	63,798,748
Corundum and emery....short tons..	1,916	56,985	2,126	61,464
Crystalline quartz....do....	31,940	74,850	19,039	88,118
Garnet for abrasive purposes....do....	3,854	117,581	5,050	148,095
Grindstones....	.....	881,527	.....	777,606
Infusorial earth and tripoli....short tons..	6,274	44,164	10,977	64,637
Millstones....	.....	37,338	.....	37,974
Oilstones, etc....	.....	188,985	.....	244,546
Arsenious oxide....pounds..	72,413	2,185	1,507,386	35,210
Borax (crude)....short tons..	45,647	698,810	46,334	1,019,154
Bromine....pounds..	897,100	269,130	1,192,758	178,914
Fluorspar....short tons..	36,452	234,755	57,385	362,488
Gypsum....do....	940,917	2,784,325	1,043,202	3,029,227
Lithium minerals....do....	577	5,155	79	1,412
Marls....do....	18,989	13,145	38,026	16,494
Phosphate rock....long tons..	1,874,428	6,580,875	1,947,190	6,763,403
Pyrite....do....	334,373	3,478,568	253,000	938,492
Sulphur....do....			181,677	3,706,560
Salt....barrels..	22,030,002	6,021,222	25,966,122	6,095,922
Barytes (crude)....short tons..	65,727	174,958	48,235	148,803
Cobalt oxide....pounds..	22,000	42,600	.....	.....
Mineral paints....short tons..	64,592	1,448,551	63,521	1,697,130
Zinc white....do....	63,363	4,808,482	68,603	5,520,240
Asbestos....do....	1,480	25,740	3,109	42,975
Asphalt....do....	108,572	879,836	115,267	758,153
Bauxite....long tons..	47,661	235,704	48,129	240,292
Chromic iron ore....do....	123	1,845	22	375
Feldspar....short tons..	45,188	266,326	35,419	226,157
Fibrous talc....do....	64,005	507,400	56,500	445,000
Fuller's earth....do....	29,480	168,500	25,178	214,497
Glass sand....do....	858,719	796,492	1,060,334	1,107,730
Graphite (crystalline)....pounds..	5,681,177	321,372	6,036,567	318,211
Graphite (amorphous)....short tons..	16,927		21,953	
Magnesite....do....	2,850	9,298	3,933	15,221
Manganese ore....long tons..	3,146	29,466	4,118	36,214
Mica (sheet)....pounds..	668,358	109,462	924,875	160,732
Mica (scrap)....short tons..	1,096	10,854	1,126	17,856
Mineral waters....gallons sold..	41,969,145	6,218,873	46,544,361	6,491,251
Monazite and zircon....pounds..	745,999	85,038	1,352,418	163,908
Precious stones....	.....	324,300	.....	326,350
Pumice stone....short tons..	1,530	5,421	1,832	5,540
Quartz (flint)....do....	52,270	100,590	51,145	104,109
Rutile....pounds..	.....	7,000	.....	.....
Sand, molding, etc., and gravel....short tons..	9,821,009	4,951,607	22,144,633	10,115,915
Talc and soapstone....do....	27,184	433,331	40,134	637,062
Tungsten....do....	740	184,000	803	268,676
Uranium and vanadium....do....	45	10,600	4	375
Total value of nonmetallic mineral products....	.....	859,543,144	.....	921,727,456
Total value of metallic products....	.....	502,149,624	.....	700,418,946
Estimated value of mineral products unspecified....	.....	400,000	.....	400,000
Grand total....	.....	1,362,092,768	.....	1,622,546,402

Mineral products of the United States for the caleadar years 1880–1913—Continued.

Product.	1906		1907	
	Quantity.	Value.	Quantity.	Value.
METALS.				
Pig iron, (spot value)..long tons..	25,307,191	$505,700,000	25,781,361	$529,958,000
Silver, commercial value..troy ounces..	56,517,900	38,256,400	56,514,700	37,299,700
Gold, coining value..do....	4,565,333	94,373,800	4,374,827	90,435,700
Copper, value at New York City..pounds..	917,805,682	177,595,888	868,996,491	173,799,300
Lead, value at New York City..short tons..	350,153	39,917,442	375,099	39,760,494
Zinc, value at New York City..do....	199,694	24,462,668	223,745	26,401,910
Quicksilver, value at San Francisco..flasks..	26,238	958,634	21,567	828,931
Aluminum, value at Pittsburgh..pounds..	14,910,000	4,262,286	17,211,039	4,926,948
Antimony, value, San Francisco, short tons.	1,766	602,949	351	77,300
Antimonial lead..do....	.....	.....	9,910	1,322,985
Nickel, value at Philadelphia..pounds..	.....	(a)	.....	(a)
Tin..do....	.....	35,600	.....	33,285
Platinum, value at New York City, troy ounces	1,439	45,189	357	10,589
Total value of metallic products.....	.....	886,110,856	.....	904,855,142
NONMETALS (SPOT VALUE).				
Bituminous coal..short tons..	342,874,867	381,162,115	394,759,112	451,214,842
Pennsylvania anthracite..long tons..	63,645,010	131,917,694	76,432,421	163,584,056
Natural gas.....	.....	46,873,932	.....	54,222,399
Petroleum..barrels..	126,493,936	92,444,735	166,095,335	120,106,749
Clay products.....	.....	161,032,722	.....	158,942,369
Cement..barrels..	51,000,445	55,302,277	52,230,342	55,903,851
Lime..short tons..	3,198,087	12,480,653	3,092,524	12,656,705
Sand-lime brick.....	.....	1,170,005	.....	1,225,769
Slate.....	.....	5,668,346	.....	6,019,220
Stone.....	.....	66,378,794	.....	71,105,805
Corundum and emery..short tons..	1,160	44,310	1,069	12,294
Abrasive quartz and feldspar..do....	24,082	121,671	17,435	126,582
Garnet for abrasive purposes..do....	4,650	157,000	7,058	211,686
Grindstones.....	.....	744,894	.....	896,022
Infusorial earth and tripoli..short tons..	8,099	72,108	.....	104,406
Millstones.....	.....	48,590	.....	31,741
Oilstones, etc.....	.....	268,070	.....	264,188
Arsenious oxide..pounds..	1,474,000	63,460	3,502,000	163,000
Borax (crude)..short tons..	58,173	1,182,410	52,850	1,121,520
Bromide..pounds..	1,283,250	165,204	1,379,496	195,281
Fluorspar..short tons..	40,796	244,025	49,486	287,282
Gypsum..do....	1,540,585	3,837,975	1,751,748	4,942,264
Lithium minerals..do....	383	7,411	530	11,000
Marls..do....	19,104	7,341	14,091	8,429
Phosphate rock..long tons..	2,080,957	8,579,437	2,265,343	10,653,558
Pyrite..do....	261,422	931,305	247,387	794,949
Sulphur..do....	294,153	5,096,678	293,106	5,142,850
Salt..barrels..	28,172,380	6,658,350	29,704,128	7,608,323
Barytes (crude)..short tons..	50,231	160,367	89,621	291,777
Cobalt oxide..pounds..	.....	(a)	.....	(a)
Mineral paints..short tons..	69,071	2,165,808	75,566	2,984,935
Zinc oxide..do....	74,680	5,999,375	71,784	6,490,660
Asbestos..do....	1,695	28,565	653	11,899
Asphalt..do....	138,059	1,290,340	223,861	2,826,489
Bauxite..long tons..	75,332	368,311	97,776	480,330
Chromic iron ore..do....	107	1,800	290	5,640
Feldspar..short tons..	75,656	401,531	84,544	499,069
Fibrous talc..do....	61,672	557,200	67,800	626,000
Fuller's earth..do....	32,040	265,400	32,851	291,773
Glass sand..do....	1,089,430	1,208,788	1,187,296	1,250,067
Graphite (crystalline)..pounds..	5,887,982	238,064	4,947,840	171,149
Graphite (amorphous)..short tons..	16,853	102,175	26,803	125,821
Magnesite..do....	7,805	23,415	7,561	22,683
Manganese ore..long tons..	6,921	88,132	5,604	63,369
Manganiferous ore..do....	41,300	122,400	103,844	259,473
Mica (sheet)..pounds..	1,423,100	252,248	1,060,182	349,311
Mica (scrap)..short tons..	1,489	22,742	3,025	42,800
Mineral waters..gallons sold..	48,108,580	8,028,387	52,060,520	7,331,503
Monazite and zircon..pounds..	847,275	152,560	548,152	65,800
Precious stones.....	.....	b 589,000	.....	b 735,800
Pumice..short tons..	12,200	16,750	8,112	33,818
Quartz..do....	66,697	243,012	22,977	157,094
Rutile..pounds..	.....	.....	.....	(a)
Sand, molding, etc., and gravel..short tons..	31,842,572	11,489,420	40,664,622	13,242,002
Talc and soapstone..do....	58,972	874,356	72,010	995,047
Tungsten..do....	928	348,867	1,640	890,048
Uranium and vanadium..do....	.....	(a)	.....	(a)
Total value of nonmetallic mineral products	.....	1,017,700,525	.....	1,167,711,497
Total value of metallic products.....	.....	886,110,856	.....	904,855,142
Estimated value of mineral products unspecified.....	.....	200,000	.....	100,000
Grand total.....	.....	1,904,011,381	.....	2,072,666,639

a Included under unspecified. b Includes pearls valued at $381,000 in 1906 and at $264,500 in 1907.

Mineral products of the United States for the calendar years 1880–1913—Continued.

Product.		1908	
		Quantity.	Value.
METALS.			
Pig iron (spot value)	long tons	15,936,018	$254,321,000
Silver, commercial value	troy ounces	52,440,800	28,050,600
Gold, coining value	do	4,574,340	94,560,000
Copper, value at New York City	pounds	942,570,721	124,419,335
Lead, value at New York City	short tons	310,762	26,104,008
Zinc, value at St. Louis	do	190,749	17,930,406
Quicksilver, value at San Francisco	flasks	19,752	824,146
Aluminum	pounds	11,152,000	2,434,600
Antimony	short tons		
Antimonial lead	do	13,629	1,264,771
Nickel, value at Philadelphia	pounds		(a)
Tin	do		
Platinum, value at New York City	troy ounces	750	14,250
Total value of metals			549,923,116
NONMETALS (SPOT VALUE).			
Bituminous coal	short tons	332,573,944	374,135,268
Pennsylvania anthracite	long tons	74,347,102	158,178,849
Natural gas			54,640,374
Petroleum	barrels	178,527,355	129,079,184
Peat			133,000
Clay products			133,197,762
Cement	barrels	52,910,925	44,477,653
Lime	short tons	2,766,873	11,091,186
Sand (molding, building, etc.), and gravel	do	36,122,491	12,135,433
Sand-lime brick			1,029,699
Slate			6,316,817
Stone			65,712,499
Corundum and emery	short tons	699	8,745
Garnet for abrasive purposes	do	1,996	64,620
Grindstones			536,095
Infusorial earth and tripoli	short tons		97,442
Millstones			31,420
Oilstones, etc			217,284
Pumice	short tons	10,569	39,287
Arsenious oxide	pounds		(a)
Borax (crude)	short tons	25,000	975,000
Bromine	pounds	760,023	73,783
Fluorspar	short tons	38,785	225,998
Gypsum	do	1,721,829	4,075,824
Lithium minerals	do	203	1,550
Marls	do	8,469	4,330
Phosphate rock	long tons	2,386,138	11,399,124
Pyrite	do	222,598	857,113
Sulphur	do	369,444	6,668,215
Salt	barrels	28,822,062	7,553,632
Barytes (crude)	short tons	38,527	120,442
Cobalt oxide	pounds		(a)
Mineral paints	short tons	69,244	2,367,723
Zinc oxide	do	56,292	5,072,460
Asbestos	do	926	19,624
Asphalt	do	198,382	2,057,881
Bauxite	long tons	52,167	263,968
Chromic iron ore	do	359	7,230
Feldspar	short tons	70,474	428,553
Fuller's earth	do	29,714	278,367
Gems and precious stones			415,063
Glass sand	short tons	1,093,553	1,134,599
Graphite (crystalline)	pounds	2,288,000	132,840
Graphite (amorphous)	short tons	1,443	75,250
Magnesite	do	6,587	19,761
Manganese ore	long tons	6,144	62,779
Manganiferous ore	do	55,620	132,556
Mica (sheet)	pounds	972,964	234,021
Mica (scrap)	short tons	2,417	33,904
Mineral waters	gallons sold	55,868,820	6,712,680
Quartz	short tons	47,316	190,157
Talc and soapstone	do	46,615	703,832
Talc, fibrous	do	70,739	697,390
Thorium minerals (monazite) and zircon	pounds	422,646	50,718
Titanium ore (rutile)	do		
Tungsten ore	short tons	671	229,955
Uranium and vanadium minerals	do		
Total value of nonmetals			1,044,398,939
Total value of metals			549,923,116
Estimated value of mineral products unspecified [a]			250,000
Grand total			1,594,572,055

[a] Included under unspecified.

Mineral products of the United States for the calendar years 1880–1913—Continued.

Product.		1909	
		Quantity.	Value.
METALS.			
Pig iron (spot value)	long tons	27,795,471	$419,175,000
Silver, commercial value	troy ounces	54,721,500	28,455,200
Gold, coining value	do	4,821,701	99,673,400
Copper, value at New York City	pounds	1,092,951,624	142,083,711
Lead, value at New York City	short tons	363,319	31,245,434
Zinc, value at St. Louis	do	230,225	24,864,300
Quicksilver, value at San Francisco	flasks	21,075	957,859
Aluminum	pounds	34,210,000	6,575,000
Antimony	short tons	.....	.....
Antimonial lead	do	12,896	1,231,019
Nickel, value at Philadelphia	pounds	.....	(a)
Tin	do	.....	4,832
Platinum, value at New York City	troy ounces	638	15,950
Total value of metals		.....	754,281,705
NONMETALS (SPOT VALUE).			
Bituminous coal	short tons	379,744,257	405,486,777
Pennsylvania anthracite	long tons	72,384,249	149,181,587
Natural gas		.....	63,206,941
Petroleum	barrels	183,170,874	128,328,487
Peat		.....	127,042
Clay products		.....	166,321,213
Cement	barrels	66,689,715	53,610,563
Lime	short tons	3,484,974	13,846,072
Sand (molding, building, etc.) and gravel	do	58,461,100	17,173,615
Sand-lime brick		.....	1,150,580
Slate		.....	5,441,418
Stone		.....	71,345,199
Corundum and emery	short tons	1,580	18,185
Garnet for abrasive purposes	do	2,972	102,315
Grindstones		.....	804,051
Infusorial earth and tripoli	short tons	.....	122,348
Millstones		.....	35,393
Oilstones, etc		.....	214,019
Pumice	short tons	15,103	33,439
Arsenious oxide	pounds	2,428,000	52,946
Borax (crude)	short tons	41,434	1,534,365
Bromine	pounds	569,725	57,600
Fluorspar	short tons	50,742	291,747
Gypsum	do	2,252,785	5,906,738
Lithium minerals	do	.....	(a)
Phosphate rock	long tons	2,338,264	10,796,456
Pyrite	do	247,070	1,028,157
Sulphur	do	239,312	4,432,066
Salt	barrels	30,107,646	8,343,831
Barytes (crude)	short tons	61,945	209,737
Cobalt oxide	pounds	.....	(a)
Mineral paints	short tons	78,771	2,373,805
Zinc oxide	do	68,974	6,156,755
Asbestos	do	3,085	62,603
Asphalt	do	228,655	2,138,273
Bauxite	long tons	129,101	679,447
Chromic iron ore	do	598	8,300
Feldspar	short tons	76,539	424,602
Fuller's earth	do	33,486	301,604
Gems and precious stones		.....	534,380
Glass sand	short tons	1,104,451	1,163,375
Graphite (crystalline)	pounds	6,294,400	313,271
Graphite (amorphous)	short tons	5,096	32,238
Magnesite	do	9,465	37,860
Manganese ore	long tons	1,544	19,675
Manganiferous ore	do	68,654	215,925
Mica (sheet)	pounds	1,809,582	234,482
Mica (scrap)	short tons	4,090	46,047
Mineral waters	gallons sold	64,674,486	6,894,134
Quartz	short tons	135,469	249,466
Talc and soapstone	do	81,802	862,002
Talc, fibrous	do	48,536	359,957
Thorium minerals (monazite) and zircon	pounds	543,931	65,282
Titanium ore (rutile)	do	.....	10,000
Tungsten ore	short tons	1,619	614,370
Uranium and vanadium minerals	do	.....	(a)
Total value of nonmetals		.....	1,133,000,740
Total value of metals		.....	754,281,705
Estimated value of mineral products unspecified a		.....	300,000
Grand total		.....	1,887,582,445

a Included under unspecified.

Mineral products of the United States for the calendar years 1880–1913—Continued.

Product.	1910		1911	
	Quantity.	Value.	Quantity.	Value.
METALS.				
Pig iron (spot value).long tons (2,240 lbs.)	26,674,123	$412,162,486	23,257,288	$327,334,624
Ferro-alloys.....do	.....	.....	253,375	8,377,832
Silver, commercial value.....troy ounces	57,137,900	30,854,500	60,399,400	32,615,700
Gold, coining value.....do	4,657,018	96,269,100	4,687,053	96,890,000
Copper, value at New York.....pounds	1,080,159,509	137,180,257	1,097,232,749	137,154,092
Lead, value at New York.....short tons	389,211	34,250,568	405,863	36,527,670
Zinc, value at St. Louis.....do	252,479	27,267,732	271,621	30,964,794
Quicksilver, value at San Francisco.flasks	20,601	958,153	21,256	977,989
Aluminum.....pounds	47,734,000	8,955,700	46,125,000	8,084,000
Antimonial lead.....short tons	14,069	1,338,090	14,078	1,380,556
Nickel, value at Philadelphia.....pounds	.....	(a)	.....	127,000
Tin.....do	.....	23,447	.....	56,635
Platinum, value at New York.troy ounces	773	25,277	940	40,890
Total value of metals.....	.....	749,285,310	.....	680,531,782
NONMETALS (SPOT VALUE).				
Bituminous coal.....short tons	417,111,142	469,281,719	405,907,059	451,375,819
Pennsylvania anthracite.....long tons	75,433,246	160,275,302	80,771,488	175,189,392
Natural gas.....	.....	70,756,158	.....	74,621,534
Petroleum.....barrels (42 galls.)	209,557,248	127,899,688	220,449,391	134,044,752
Peat.....	.....	140,209	.....	272,114
Clay products.....	.....	170,115,974	.....	162,236,181
Cement.....barrels (380 lbs., net)	77,785,141	68,752,092	79,547,958	66,705,136
Glass sand.....short tons	1,461,089	1,516,711	1,538,666	1,543,733
Gypsum.....do	2,379,057	6,523,029	2,323,970	6,462,035
Lime.....do	3,505,954	14,088,039	3,392,915	13,689,054
Sand and gravel.....short tons	67,949,347	19,520,919	65,308,293	19,614,850
Sand-lime brick.....	.....	1,169,153	.....	897,664
Slate.....	.....	6,236,759	.....	5,728,019
Stone.....	.....	76,520,584	.....	77,108,567
Corundum and emery.....short tons	1,028	15,077	659	6,778
Garnet for abrasive purposes.....do	3,814	113,574	4,076	121,748
Grindstones.....	.....	796,294	.....	907,316
Infusorial earth and tripoli ....short tons	.....	130,006	.....	147,462
Millstones.....	.....	28,217	.....	40,069
Oilstones, etc.....	.....	228,694	.....	214,991
Pumice.....short tons	23,271	94,943	21,689	88,399
Arsenious oxide.....pounds	2,994,000	52,305	6,264,000	73,408
Borax.....short tons	42,357	1,201,842	53,330	1,569,151
Bromine.....pounds	245,437	31,684	651,541	110,902
Calcium chloride.....short tons	10,971	74,713	14,606	91,215
Fluorspar.....do	69,427	430,196	87,048	611,447
Phosphate rock.....long tons	2,654,988	10,917,000	3,053,279	11,900,693
Pyrite.....do	241,612	977,978	301,458	1,164,871
Sulphur.....do	255,534	4,605,112	265,664	4,787,049
Sulphuric acid (60° Baumé)...short tons	.....	.....	438,300	2,733,696
Salt.....barrels (280 lbs., net)	30,305,656	7,900,344	31,183,968	8,345,692
Barytes (crude).....short tons	42,975	121,746	38,445	122,792
Mineral paints.....do	85,304	2,141,654	143,350	7,842,583
Zinc oxide.....do	58,481	5,238,945		
Asbestos.....do	3,693	68,357	7,604	119,935
Asphalt.....do	260,080	3,080,067	364,266	3,991,109
Bauxite.....long tons	148,932	716,258	155,618	750,649
Chromic iron ore.....do	205	2,729	120	1,629
Feldspar.....short tons	81,102	502,452	92,700	579,008
Fuller's earth.....do	32,822	293,709	40,697	383,124
Gems and precious stones.....	.....	295,797	.....	343,692
Graphite.....{crystalline, pounds	5,590,592	295,733	4,790,000	256,050
Graphite.....{amorphous, short tons	1,407	39,710	1,223	32,415
Magnesite.....do	12,443	74,658	9,375	75,000
Manganese ore.....long tons	2,258	22,892	2,457	24,586
Manganiferous ore.....do	61,101	186,765	44,437	114,918
Mica.....{sheet, pounds	2,476,190	283,832	1,887,201	310,254
Mica.....{scrap, short tons	4,065	53,265	3,512	45,550
Mineral waters.....gallons sold	62,030,125	6,357,590	63,788,552	6,837,888
Quartz.....short tons	63,577	193,757	87,943	155,122
Talc and soapstone.....do	79,006	864,213	81,521	1,032,732
Talc, fibrous.....do	71,710	728,180	62,030	613,286
Monazite and zircon.....pounds	99,301	12,006	3,208	802
Titanium ore (rutile).....do	1,132,000	44,480	.....	.....
Tungsten ore.....short tons	1,821	832,992	1,139	407,985
Uranium and vanadium minerals....do	.....	(a)	.....	305,500
Total value of nonmetals.....	.....	1,242,846,102	.....	1,246,750,346
Total value of metals.....	.....	749,285,310	.....	680,531,782
Value of products unspecified.....	.....	300,000	.....	250,000
Grand total.....	.....	1,992,431,412	.....	1,927,532,128

a Included under unspecified.

Mineral products of the United States for the calendar years 1880–1913—Continued.

Product.	1912		1913	
	Quantity.	Value.	Quantity.	Value.
METALS.				
Pig iron (spot value).long tons (2,240 lbs)..	30,180,969	$420,563,388	30,388,935	$458,342,345
Ferro-alloys.....do....	328,685	12,223,776	296,207	13,015,362
Silver, commercial value.....troy ounces..	63,766,800	39,197,500	66,801,500	40,348,100
Gold, coining value.....do....	4,520,717	93,451,500	4,299,784	88,884,400
Copper, value at New York.....pounds..	1,243,268,720	205,139,338	1,224,484,098	189,795,035
Lead, value at New York.....short tons..	415,395	37,385,550	436,430	38,405,840
Zinc, value at St. Louis.....do....	323,907	44,699,166	337,252	37,772,224
Quicksilver, value at San Francisco.flasks..	25,064	1,053,941	20,213	813,171
Aluminum.....pounds...	65,607,000	11,907,000	72,379,000	13,845,000
Antimonial lead.....short tons..	13,552	1,311,348	16,665	1,675,179
Nickel, value at Philadelphia.....pounds..	.....	(a)	.....	(a)
Tin.....do....	.....	124,800	.....	36,970
Platinum, value at New York.troy ounces..	1,005	45,778	1,034	46,530
Total value of metals.....	.....	867,103,085	.....	882,980,156
NONMETALS (SPOT VALUE).				
Bituminous coal.....short tons..	450,104,982	517,983,445	478,523,203	565,307,658
Pennsylvania anthracite.....long tons..	75,322,855	177,622,626	81,718,680	195,181,127
Natural gas.....	.....	84,563,957	.....	87,846,677
Petroleum.....barrels (42 galls.)..	222,935,044	164,213,247	248,446,230	237,121,388
Peat.....	.....	228,572	.....	197,200
Clay products.....	.....	172,811,275	.....	181,289,132
Cement.....barrels (380 lbs., net)..	83,351,191	67,461,513	92,949,102	93,001,169
Glass sand.....short tons..	1,465,386	1,430,471	1,791,800	1,895,991
Gypsum.....do....	2,500,757	6,563,908	2,599,508	6,774,822
Lime.....do....	3,529,462	13,970,114	3,595,390	14,648,362
Sand and gravel.....short tons..	66,889,175	21,682,737	77,764,049	22,321,517
Sand-lime brick.....	.....	1,200,223	.....	1,238,325
Slate.....	.....	6,043,318	.....	6,175,476
Stone.....	.....	78,193,220	.....	83,732,995
Corundum and emery.....short tons..	992	6,652	957	4,785
Garnet for abrasive purposes.....do....	4,947	163,237	5,308	183,422
Grindstones.....	.....	916,339	.....	855,627
Diatomaceous earth and tripoli..short tons..	.....	125,446	.....	285,821
Millstones.....	.....	71,414	.....	56,163
Oilstones, etc.....	.....	232,218	.....	207,352
Pumice.....short tons..	27,146	86,687	24,563	55,408
Arsenious oxide.....pounds..	6,282,000	190,757	5,026,000	159,236
Borax.....short tons..	42,315	1,127,813	58,051	1,491,530
Bromine.....pounds..	647,200	145,805	572,400	115,436
Calcium chloride.....short tons..	18,550	117,272	19,611	130,030
Fluorspar.....do....	116,545	769,163	115,580	736,286
Phosphate rock.....long tons..	2,973,332	11,675,774	3,111,221	11,796,231
Pyrite.....do....	350,928	1,334,259	341,338	1,286,084
Sulphur.....do....	303,472	5,256,422	311,590	5,479,849
Sulphuric acid (60° Baumé).....short tons..	614,073	4,240,941	632,237	4,346,272
Salt.....barrels (280 lbs., net)..	33,324,808	9,402,772	34,399,298	10,123,139
Barytes (crude).....short tons..	37,478	153,313	45,298	156,275
Mineral paints.....do....	181,154	10,069,588	173,168	9,543,306
Zinc oxide.....do....				
Asbestos.....do....	4,403	87,959	1,100	11,000
Asphalt.....do....	449,510	4,620,731	529,190	5,282,370
Bauxite.....long tons..	159,865	768,932	210,241	997,698
Chromic iron ore.....do....	201	2,753	255	2,854
Feldspar.....short tons..	86,572	520,562	120,955	776,551
Fuller's earth.....do....	32,715	305,522	38,594	369,750
Gems and precious stones.....	.....	319,722	.....	319,454
Graphite.....{crystalline, pounds....	3,543,771	187,689	5,064,727	254,328
Graphite.....{amorphous, short tons..	2,063	32,894	2,243	39,428
Magnesite.....do....	10,512	84,096	9,632	77,056
Manganese ore.....long tons..	1,664	15,723	4,048	40,480
Manganiferous ore.....do....	51,517	19,942	59,403	25,124
Mica.....{sheet, pounds....	845,483	282,823	1,700,677	353,517
Mica.....{scrap, short tons..	3,226	49,073	5,322	82,543
Mineral waters.....gallons sold..	62,281,201	6,615,671	57,867,399	5,631,391
Quartz.....short tons..	97,874	191,685	204,759	668,011
Talc and soapstone.....do....	92,403	1,050,693	94,128	1,119,597
Talc, fibrous.....do....	66,867	656,270	81,705	788,500
Titanium ore (rutile).....pounds..	550,000	.....	610,000	49,000
Tungsten ore.....short tons..	1,330	502,158	1,537	672,118
Uranium and vanadium minerals....do....	.....	(a)	.....	b 1,020,000
Total value of nonmetals.....	.....	1,376,369,396	.....	1,562,324,861
Total value of metals.....	.....	867,103,085	.....	882,980,156
Value of products unspecified.....	.....	500,000	.....	500,000
Grand total.....	.....	2,243,972,481	.....	2,445,805,017

a Included under unspecified. b Estimated value of recoverable radium in ore when extracted.

TOTAL VALUE OF MINERAL PRODUCTION OF THE UNITED STATES FROM 1880 TO 1913.

The following table and the diagram opposite show the value, year by year, of the mineral production of the United States as reported to the United States Geological Survey from 1880 to 1913, inclusive:

Total value of mineral production of the United States from 1880 to 1913, by years.

Year.	Metals.	Nonmetals.	Unspecified products.	Total.
1880	$185,649,163	$173,279,135	$6,000,000	$364,928,298
1881	187,549,908	206,783,144	6,500,000	400,833,052
1882	214,061,009	231,340,150	6,500,000	451,901,159
1883	196,547,259	243,812,214	6,500,000	446,859,473
1884	179,230,899	221,879,506	5,000,000	406,110,405
1885	172,491,087	241,312,093	5,000,000	418,803,180
1886	203,249,225	230,088,769	800,000	434,137,994
1887	236,598,254	270,989,420	800,000	508,387,674
1888	237,574,422	286,150,114	900,000	524,624,536
1889	247,768,701	282,623,812	1,000,000	531,392,513
1890	292,649,877	312,826,503	1,000,000	606,476,380
1891	282,617,183	321,767,846	1,000,000	605,385,029
1892	281,514,539	340,028,842	1,000,000	622,543,381
1893	219,436,649	323,257,318	1,000,000	542,693,967
1894	185,804,594	362,570,173	1,900,000	549,374,767
1895	245,874,431	393,897,097	1,000,000	640,771,528
1896	251,445,519	388,098,702	1,000,000	640,544,221
1897	265,209,975	380,782,607	1,000,000	646,992,582
1898	305,482,183	417,790,671	1,000,000	724,272,854
1899	487,831,631	525,524,074	1,000,000	1,014,355,705
1900	511,632,891	594,398,501	1,000,000	1,107,031,392
1901	480,006,859	660,850,112	1,000,000	1,141,856,971
1902	599,916,009	722,027,126	1,000,000	1,322,943,135
1903	583,433,948	905,242,380	1,900,000	1,489,676,328
1904	502,149,624	859,543,144	400,000	1,362,092,768
1905	700,418,946	921,727,456	400,000	1,622,546,402
1906	886,110,856	1,017,700,525	200,000	1,904,011,381
1907	904,855,142	1,167,711,497	100,000	2,072,666,639
1908	549,923,116	1,044,398,939	250,000	1,594,572,055
1909	754,281,705	1,133,000,740	300,000	1,887,582,445
1910	749,285,310	1,242,846,102	300,000	1,992,431,412
1911	680,531,782	1,246,750,346	250,000	1,927,532,128
1912	867,103,085	1,376,369,396	500,000	2,243,972,481
1913	882,980,156	1,562,324,861	500,000	2,445,805,017
Grand total	14,531,215,937	20,609,693,315	56,200,000	35,197,109,252

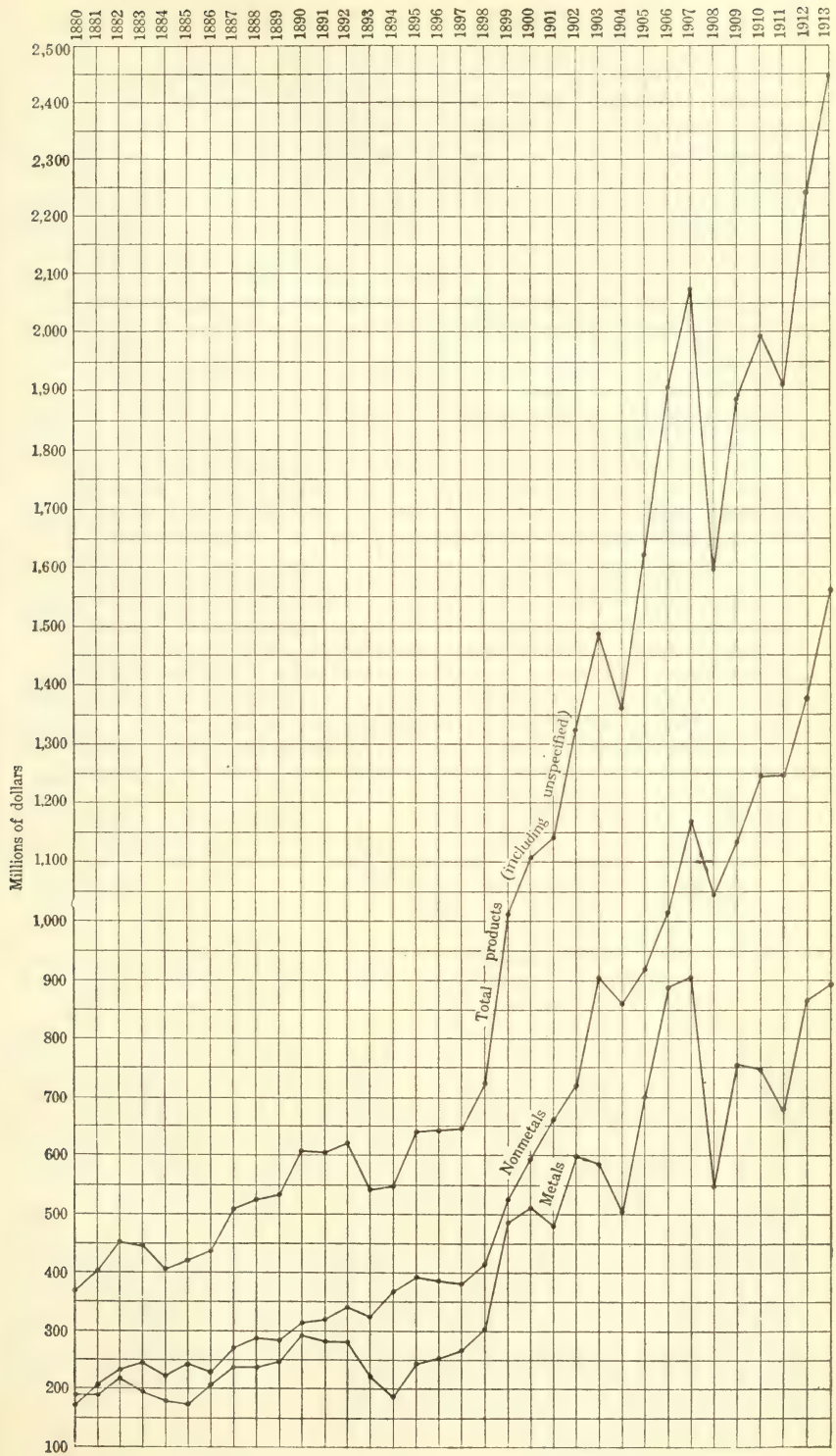

FIGURE A.—Curves showing value of mineral products in the United States, 1880–1913.

IMPORTS AND EXPORTS.

The following table shows the value for the calendar years 1912 and 1913 of the imports for consumption and of the exports of the mineral products included in this report as furnished by the Bureau of Foreign and Domestic Commerce of the Department of Commerce. As has been noted elsewhere, "imports for consumption" may or may not be identical with "total imports" for the calendar year. Thus, total imports valued at $500,000 may all be entered for consumption, or $50,000 of these imports may be entered in bond and be reported for consumption in the following calendar year. These differences tend to equalize. Thus, in the five years from 1903 to 1907, inclusive, the general imports of iron ores exceeded the imports for consumption by less than 7,500 long tons in total imports of about 4,603,000 tons. The difference for a single year may, however, be considerable.

The imports of metals (exclusive of gold and silver) increased in value $2,065,474, or 1.52 per cent, from $135,968,958 in 1912 to $138,034,432 in 1913; and the exports increased by $18,681,480, or 12.80 per cent, from $145,884,749 to $164,566,229. The imports of nonmetallic products increased in value $19,799,223, or 15.21 per cent, from $130,206,621 in 1912 to $150,005,844 in 1913, and the exports increased $47,832,634, or 21.37 per cent, from $223,841,201 in 1912 to $271,673,835 in 1913. The total imports of mineral products, metals (exclusive of gold and silver) and nonmetals, increased $21,864,697, and the total exports in 1913 increased $66,514,114. Copper constituted about 90 per cent of the metallic exports and petroleum and its derivatives about 60 per cent of the nonmetallic exports. Copper constituted about 42 per cent and tin about 34 per cent of the imported metals; gems and precious stones made up about 31 per cent and fertilizers almost 29 per cent of the nonmetallic imports.

Value of imports for consumption and of exports of mineral products in the calendar years 1912 and 1913.

METALS.

Product.	1912	1913
IMPORTS.		
Aluminum salts	$84,606	$66,549
Antimony (metal regulus, and ore)	859,917	936,361
Antimony salts	81,077	117,169
Bauxite	95,431	85,746
Bismuth	316,440	213,257
Cadmium	3,764	1,232
Chromic iron ore	499,818	622,821
Chromium salts	4,461	2,919
Cobalt (oxide ore and zaffer)	83,080	95,735
Copper, in ore, matte, ingots, bars, manufactures, etc	57,012,057	57,901,901
Iron ore	6,499,690	8,336,819
Ferro-alloys:		
Ferrochrome	77,587	51,415
Ferromanganese	3,906,920	5,682,915
Ferromolybdenum	4,670	15,939
Ferrophosphorus	4,465	.....
Ferrosilicon	446,456	449,871
Ferrotitanium	7,631	7,198
Ferrotungsten	323,872	835,212
Ferrovanadium	.....	.....
Spiegeleisen	28,094	2,173
Lead, in ore, base bullion, pigs, sheets, manufactures, etc	605,551	572,980
Manganese ore	1,769,184	2,029,680
Nickel, in ore, matte, oxide, etc	5,758,967	6,600,755
Platinum	4,503,682	5,040,210

Value of imports for consumption and of exports of mineral products in the calendar years 1912 and 1913—Continued.

METALS—Continued.

Product.	1912	1913
IMPORTS—continued.		
Quicksilver	$39,920	$75,361
Tin	50,372,478	46,946,756
Tungsten ore	362,422	213,122
Type metal	18,668	20,098
Uranium salts and oxide, including some radium salts	32,642	42,180
Zinc, in ore, pigs, sheets, dust, manufactures, etc	1,952,011	1,068,058
Iridium, osmium, palladium, and rhodium	213,397	.....
Total	135,968,958	138,034,432
Increase	.....	2,065,474
Percentage of increase	.....	1.52
EXPORTS.		
Aluminum and manufactures, etc	1,347,621	966,094
Copper, in ore, matte, ingots, bars, manufactures, etc	129,973,387	147,883,114
Iron ore	3,537,289	3,513,419
Lead, in ore, base bullion, pigs, sheets, manufactures, etc	651,459	738,135
Nickel, in ore, matte, oxide, etc	8,515,332	9,686,794
Quicksilver	13,360	43,574
Zinc, in ore, pigs, sheets, dust, manufactures, etc	1,846,301	1,735,099
Total	145,884,749	164,566,229
Increase	.....	18,681,480
Percentage of increase	.....	12.81

NONMETALS.

IMPORTS.		
Alizarin	$1,514,344	$1,493,840
Aniline salts	354,226	323,420
Arsenic sulphides, etc	428,741	410,446
Asbestos	1,819,771	2,307,666
Asphalt	921,145	910,611
Barytes	79,315	99,564
Barium compounds	376,017	391,470
Borax	11,249	18,434
Burrstones and millstones	27,562	40,198
Cement, hydraulic	93,558	138,187
Clay, other than kaolin	323,131	382,782
Clay products:		
Brick and tile, etc	215,379	276,677
Pottery, etc	9,555,530	10,177,451
Coal:		
Anthracite	8,329	5,620
Bituminous	4,509,066	3,853,930
Coal-tar products	8,862,525	9,142,599
Coke	488,398	435,157
Corundum and emery	491,725	474,299
Cryolite	48,293	52,557
Fertilizers:		
Crude (guano, kainite, manure salts, phosphates, etc.)	8,893,090	10,819,253
Potassium chloride	7,229,121	7,075,745
Potassium sulphate	1,783,846	1,677,429
Other potassium salts	1,679,318	2,040,739
Sodium nitrate	16,544,511	21,630,811
Flint and flint pebbles	292,052	319,509
Fluorspar	71,616	71,463
Fuller's earth	145,337	146,001
Gems and precious stones	41,363,325	45,431,998
Granite	112,338	115,525
Graphite	1,709,337	2,109,791
Grindstones	131,080	139,386
Gypsum	488,481	556,922
Hones, oilstones, whetstones	45,398	40,222
Diatomaceous earth, rotten stone, and tripoli	24,253	28,696
Kaolin or china clay	1,629,105	1,623,993
Lead paints—litharge, orange mineral, red lead, white lead	119,812	74,127
Lime	48,153	48,538
Magnesite and magnesia	1,430,542	1,860,557
Marble and stone	1,449,893	1,490,610
Mica	748,973	943,018
Mineral waters	930,091	955,788

Value of imports for consumption and of exports for mineral products in the calendar years 1912 and 1913—Continued.

NONMETALS—Continued.

Product.	1912	1913
IMPORTS—continued.		
Monazite and thorium oxide	$47,334	$68,543
Ocher	148,306	143,720
Peat	39,867	55,719
Petroleum	6,082,881	12,947,280
Ozokerite and paraffin	1,018,524	982,352
Pumice	74,478	93,408
Pyrite	3,841,683	3,611,137
Salt	370,648	421,745
Sand and gravel	141,690	172,257
Sienna and umber	77,420	85,306
Slate	14,768	5,479
Salicylic acid	9,543	2,969
Sulphur	583,974	448,564
Talc	122,956	137,680
Thorium nitrate	225,386	230,628
Venetian red	22,916	25,927
Zinc oxide	386,153	434,156
Gasoline	118	1,661
Strontium salts	.....	2,284
Total	130,206,621	150,005,844
Increase	.....	19,799,223
Percentage of increase	.....	15.21
Grand total imports	266,175,579	288,040,276
Increase	.....	21,864,697
Percentage of increase	.....	8.21
EXPORTS.		
Asphalt	[a] 1,170,882	[a] 1,640,027
Cement, hydraulic	6,160,341	4,270,666
Clay products:		
Brick and tile, etc	3,823,111	4,229,076
Pottery, etc	1,177,784	559,163
Coal:		
Anthracite	19,425,263	21,759,850
Bituminous	[b] 36,817,633	[b] 45,449,664
Coke	3,002,742	3,309,930
Fertilizers, phosphates, crude	8,996,456	9,996,580
Lime	199,515	212,345
Marble and stone	1,839,878	1,856,892
Petroleum	124,210,382	149,316,409
Paraffin and paraffin wax	9,602,758	8,176,831
Salt	418,525	515,194
Slate	.....	226,413
Sulphur	1,076,414	1,599,761
Zinc oxide	1,247,702	1,136,257
Gasoline (in part from natural gas)	4,671,815	17,418,777
Total	223,841,201	271,673,835
Increase	.....	47,832,634
Percentage of increase	.....	21.37
Grand total exports	369,725,950	436,240,064
Increase	.....	66,514,114
Percentage of increase	.....	17.99

[a] Asphalt and manufactures of, fiscal year.
[b] Not including bunker coal laden as fuel in vessels in the foreign trade, which aggregated in value $23,602,598 in 1912 and $25,036,272 in 1913.

If gold and silver are included, for the sake of rounding out the metals mentioned in this report, the metallic imports decreased from $250,919,356 in 1912 to $237,607,083 in 1913, and the metallic exports increased from $265,271,346 in 1912 to $319,141,470 in 1913; the total imports increased from $381,125,977 in 1912 to $387,612,927 in 1913, and the total exports increased from $489,112,547 in 1912 to $590,815,305 in 1913. The movements of gold and silver, how-

ever, are rather financial than commercial; nevertheless the following table is added to show the results mentioned above:

Value of imports for consumption and of exports of mineral products in the calendar years 1912 and 1913, including gold and silver.

Product.	1912	1913
IMPORTS.		
Gold (ore, bullion, and coin)	$66,548,772	$63,704,832
Silver (ore, bullion, and coin)	48,401,086	35,867,819
Other metals	135,968,958	138,034,432
Total	250,918,816	237,607,083
Total metals	250,918,816	237,607,083
Total nonmetals	130,206,621	150,005,844
Grand total	381,125,437	387,612,927
EXPORTS.		
Gold (ore, bullion, and coin)	47,424,842	91,798,610
Silver (ore, bullion, and coin)	71,961,755	62,776,631
Other metals	145,884,749	164,566,229
Total	265,271,346	319,141,470
Total metals	265,271,346	319,141,470
Total nonmetals	223,841,201	271,673,835
Grand total	489,112,547	590,815,305

PREFATORY NOTE TO THE GENERAL AND MINES REPORTS ON GOLD, SILVER, COPPER, LEAD, AND ZINC.

By H. D. McCaskey.

In the mining industry five metals are closely related in both the genesis and the geologic occurrence of their ores; they also hold together in mining and in metallurgical treatment. They are gold, silver, copper, lead, and zinc. Of their ores, some contain all five metals, many contain three or four, and few contain only one. Gold and silver, for instance, on the one hand, and lead and zinc, on the other, almost always stand in close genetic relations, and the ores of each two are usually mined together. Copper ores almost invariably produce some silver and gold as well as copper, and lead ores, with certain exceptions, produce notable supplies of silver. Zinc ores in the Western States contribute also to the silver production. In the same mine sometimes, and in the same mining district frequently, all five metals occur in commercial quantity.

This situation is recognized by the United States Geological Survey in its publication of the annual reports on the mineral resources of the country; hence the general treatment of each of the five metals in the general reports and the grouping together of the related metals in the various mines reports descriptive of individual or geographically grouped States.

To facilitate advance publication the complete report upon these five metals is therefore divided into sixteen sections, each of which is published separately. The first four sections give figures of output for the calendar year in marketable form for the metals named as obtained from the smelters, refineries, and mints, and general reviews of the respective industries for the entire country; the last twelve sections give the production as obtained from the mines so far as possible in terms of recoverable metal in ores and other material sold or treated during the calendar year, and supply information in detail relative to the mining industry in the respective States, counties, and mining districts. The figures given in the general reports are the final official statistics of production for the country and of the States. The general report on gold and silver includes the statistics of recovered precious metals as determined jointly by the Bureau of the Mint and the United States Geological Survey.

The sixteen sections, which appear as separate chapters in this volume, are as follows:

Gold and silver (general report).
Copper (general report).
Lead (general report).
Zinc (general report).
Gold, silver, copper, lead, and zinc in the Eastern States (mines report).
Silver, copper, lead, and zinc in the Central States (mines report).
Gold, silver, and copper in Alaska (mines report).
Gold, silver, copper, lead, and zinc in Arizona (mines report).
Gold, silver, copper, lead, and zinc in California and Oregon (mines report).
Gold, silver, copper, lead, and zinc in Colorado (mines report).
Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).
Gold, silver, copper, lead, and zinc in Montana (mines report).
Gold, silver, copper, lead, and zinc in Nevada (mines report).
Gold, silver, copper, lead, and zinc in New Mexico and Texas (mines report).
Gold, silver, copper, and lead in South Dakota and Wyoming (mines report).
Gold, silver, copper, lead, and zinc in Utah (mines report).

In measurement of ores, concentrates, and similar material the short ton of 2,000 pounds is used throughout. The ore classification is necessarily arbitrary in part. An ore is generally understood to be worked at a profit for one or more metals. The complex nature of western ores, especially, and the gradations from one well-recognized class to another render essential some fixed measures for the terminology used. The dry or siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and also precious metal bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The copper ores include those carrying over 2½ per cent of copper, or even less in the cases of the great disseminated copper deposits of the West and of the copper ores of the Lake Superior region. In general, the lead ores are those containing over 4½ per cent of lead, and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious metal content; but some ores of lower grade in lead, and especially in zinc, are treated profitably for these metals, and of course they are then classified as lead or zinc ores, as the case may be. The mixed ores are combinations of the ones enumerated.

The price per unit of metal production (gold excepted, which is fixed by law at $20.67+ per fine ounce) is based upon averages of daily market prices current at New York for silver, copper, and lead, and at St. Louis for metallic zinc or spelter. The prices used by the United States Geological Survey for calculation of values for the years 1850–1913, inclusive, are as follows:

Prices of silver, copper, lead, and zinc, 1850–1913.

Year.	Silver.	Copper.	Lead.	Zinc.
	Fine ounces.	*Pound.*	*Pound.*	*Pound.*
1850	$1.32	$0.22	$0.05	.....
1851	1.34	.166	.05	.....
1852	1.33	.22	.05	.....
1853	1.35	.22	.06	$0.055
1854	1.35	.22	.06	.....
1855	1.34	.27	.07	.....
1856	1.34	.27	.066	.....
1857	1.35	.25	.06	.....
1858	1.34	.23	.06	.....
1859	1.36	.22	.055	.....
1860	1.35	.23	.056	.....
1861	1.33	.22	.05	.....
1862	1.35	.22	.06	.....
1863	1.345	.34	.06	.....
1864	1.345	.47	.07	.139
1865	1.337	.3925	.066	.....
1866	1.339	.3425	.07	.....
1867	1.33	.2537	.065	.....
1868	1.326	.23	.065	.....
1869	1.325	.2425	.06	.....
1870	1.328	.2118	.06	.....
1871	1.325	.2412	.06	.....
1872	1.322	.3556	.064	.....
1873	1.297	.2800	.06	.....
1874	1.278	.2200	.06	.....
1875	1.24	.227	.058	.07
1876	1.16	.21	.061	.072
1877	1.20	.19	.055	.06
1878	1.15	.166	.036	.049
1879	1.12	.186	.041	.052
1880	1.15	.214	.05	.055
1881	1.13	.182	.048	.052
1882	1.14	.191	.049	.053
1883	1.11	.165	.043	.045
1884	1.11	.13	.037	.044
1885	1.07	.108	.039	.043
1886	.99	.111	.046	.044
1887	.98	.138	.045	.046
1888	.94	.168	.044	.049
1889	.94	.135	.039	.05
1890	1.05	.156	.045	.055
1891	.99	.128	.043	.05
1892	.87	.116	.04	.046
1893	.78	.108	.037	.04
1894	.63	.095	.033	.035
1895	.65	.107	.032	.036
1896	.68	.108	.03	.039
1897	.60	.12	.036	.041
1898	.59	.124	.038	.046
1899	.60	.171	.045	.058
1900	.62	.166	.044	.044
1901	.60	.167	.043	.041
1902	.53	.122	.041	.048
1903	.54	137	.042	.054
1904	.58	.128	.043	.051
1905	.61	.156	.047	.059
1906	.68	.193	.057	.061
1907	.66	.20	.053	.059
1908	.53	.132	.042	.047
1909	.52	.13	.043	.054
1910	.54	.127	.044	.054
1911	.53	.125	.045	.057
1912	.615	.165	.045	.069
1913	.604	.155	.044	.056

It is to be understood, of course, that full market values are not received by producers for metals in ore and intermediate products, nor always for metals in marketable form, that payment is made in accordance with contracts for treatment or sale, and that, therefore, average daily quotations do not necessarily agree with average prices received.

Each of the 16 sections mentioned is published in a separate pamphlet for advance distribution, and copies can be obtained, as long as the supply lasts, on request made to the Director, United States Geological Survey, Washington, D. C.

BAUXITE AND ALUMINUM.

By W. C. Phalen.

BAUXITE.

PRODUCTION.

The production of bauxite in the United States in 1913 was 210,241 long tons, valued at $997,698—a marked increase over the production of any previous year in the history of bauxite mining. This increase is attributable in large measure to the impetus in the aluminum industry. During the year the demand for aluminum has shown a steady and rapid growth, marked by steady expansion and improvement in existing plants and progress in the work on new power sites where largely increased hydroelectric power for use in reducing the metal will be in operation during the next few years. Work was commenced at a new plant in the spring of 1914.

The figures given above for the production and value of bauxite in 1913 represent an increase in quantity of 50,376 long tons, or 31.5 per cent, compared with 2.7 per cent the preceding year; in value the increase amounted to $228,766, or 29.8 per cent, compared with 2.4 per cent the preceding year.

The States which produced bauxite were, as usual, Alabama, Arkansas, Georgia, and Tennessee. Arkansas led in 1913, its output exceeding that of the previous year. The ore mined in this State came from Saline and Pulaski counties. The production of Tennessee increased substantially. The ore mined in this State came from the Mission Ridge deposits near Chattanooga and from the new mine of the National Bauxite Co., near Keenburg, Carter County. The recent developments in the Tennessee fields are described in the following pages. The production in Georgia and Alabama declined. In the former State the falling off was slight, but in Alabama it was considerable. In Georgia ore was mined near Halls Station, Bartow County, near Hermitage, Floyd County, and near McIntyre, Wilkinson County. Considerable prospecting and development work was done in the vicinity of Rome, Floyd County. The Alabama ore came from the vicinity of Rock Run, Cherokee County.

The average price of bauxite per long ton at the mines for the last four years has been as follows: 1910, $4.81; 1911, $4.82; 1912, $4.81; 1913, $4.75.

The following table gives the production and value of bauxite from 1889 to 1913, inclusive:

Production of bauxite in the United States, 1889–1913, by States, in long tons.

Year.	Georgia.	Alabama.	Arkansas.	Total.	Value.
1889	728	.....	.....	728	$2,366
1890	1,844	.....	.....	1,844	6,012
1891	3,301	292	.....	3,593	11,675
1892	5,110	5,408	.....	10,518	34,183
1893	2,415	6,764	.....	9,179	29,507
1894	2,050	9,016	.....	11,066	35,818
1895	3,756	13,313	.....	17,069	44,000
1896	7,313	11,071	.....	18,364	47,338
1897	7,507	13,083	.....	20,590	57,652
1898	.....	.....	.....	25,149	75,437
1899	15,736	14,499	5,045	35,280	125,598
1900	19,739		3,445	23,184	89,676
1901	18,038		867	18,905	79,914
1902	22,677		4,645	27,322	120,366
1903	22,374		25,713	48,087	171,306
1904	21,913		25,748	47,661	235,704
1905	15,173		32,956	48,129	240,202
1906	25,065		50,267	75,332	368,311
1907	.....		.....	[a] 97,776	480,330
1908	14,464		[a] 37,703	52,167	263,968
1909	22,227		[a] 106,874	129,101	679,447
1910	33,096		[a] 115,836	148,932	716,258
1911	30,170		[a] 125,448	155,618	750,649
1912	19,587	14,173	[a] 126,105	159,865	768,932
1913	27,409		[a] 182,832	210,241	997,698

[a] Production of Tennessee included.

CONSUMPTION.

The following table gives the annual production, imports, consumption, and value of bauxite in the United States during the last five years.

Production, imports, and consumption of bauxite in United States, 1909–1913, in long tons.

Year.	Production.		Imports.		Consumption.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1909	129,101	$679,447	18,688	$83,956	147,789	$763,403
1910	148,932	716,258	15,669	65,743	164,601	782,001
1911	155,618	750,649	43,222	164,301	198,840	914,950
1912	159,865	768,932	26,214	95,431	186,079	864,363
1913	210,241	997,698	21,456	85,746	231,697	1,083,444

WORLD'S PRODUCTION.

The following table shows the world's production of bauxite from 1910 to 1912, so far as the figures are at present available.

World's production of bauxite, 1910–1912, in long tons.

Country.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United States	148,932	$716,258	155,618	$750,649	159,865	$768,932
France	192,913	379,052	250,818	508,788	(a)	(a)
United Kingdom	3,792	4,292	6,007	6,297	5,790	6,881
Italy	4,524	8,868	5,600	12,300	6,596	20,618
India	66	122	12	24	(a)	(a)
Total	350,227	1,108,592	418,055	1,278,058	.....	.....

[a] Statistics not available.

The figures in this table were obtained from the official statistical reports of the different countries represented. The official figures for the United Kingdom were obtained from Mines and Quarries, London, and for the year 1911 the figures for France and India were also obtained from this source, the official French figures not being available. The figures for France in 1910 came from the French official publication "Statistique de l'industrie minérale." Figures for Italy were obtained from the Revista del servizio minerario.

BAUXITE INDUSTRY, BY STATES.

TENNESSEE.

CHATTANOOGA DISTRICT.

Bauxite was mined in 1913 at two localities in the vicinity of Chattanooga, Tenn.—(1) near the east end of the McCallie Avenue tunnel through Missionary Ridge and (2) at Sherman Heights. This work has been done by the National Bauxite Co., which is reported to have purchased the Bennett property, near the end of the Missionary Ridge car line, about 2½ miles south of the tunnel. Between Sherman Heights and the tunnel are the holdings of the Aluminum Co. of America, on which some prospecting has been done in previous years. All the deposits that have been worked are situated on the southeast slope of the ridge.

Tunnel deposits.—Chattanooga, Tenn., is separated from the country to the east by Missionary Ridge, which rises to a height of about 1,000 feet, or approximately 300 feet above the flood plain of Tennessee River, on which the city is built. Hamilton County, of which Chattanooga is the county seat, has recently constructed through the ridge a tunnel 931 feet long, which is an eastward continuation of McCallie Avenue, and has thereby opened a direct route into the city from the country east of the ridge.

During the construction of the tunnel bauxite was encountered at a point 60 feet from the east end and extending some distance to the west. This distance is not known, as no records were kept. Lignite was observed by the writer at the east end of the tunnel, as were also the characteristic variegated clays usually associated with bauxite. The residual soil here is also filled with chert débris. Still farther east of the tunnel the bauxite is being worked on a small scale by the National Bauxite Co. It thus appears that there may be two distinct pockets or deposits of the ore in this immediate locality.

The company is working only on a small scale at the eastern deposit, having the mineral rights on a small acreage that is privately owned. When the deposit was examined by the writer early in May, 1913, two shallow pits had been sunk and a tunnel 60 feet long had been excavated. The deposit is being worked on a royalty basis, a certain sum corresponding to a certain tonnage being guaranteed to hold the lease. After this tonnage is removed a certain royalty per ton is to be paid. The ore after removal is hauled to Sherman Heights, where it is dried. It is stated that the ore mined will average 50 per cent alumina (Al_2O_3).

Sherman Heights.—The most important deposits of bauxite in Tennessee at the present time are situated near Sherman Heights, on the southeast slope of Missionary Ridge, near Chattanooga. The

deposits are most conveniently reached by trolley to Sherman Heights and are about half a mile south of the tunnel of the Southern Railway Co., which pierces the ridge in this suburb.

Formerly there were two mines or pits near this place, situated within 250 yards of each other on a northeast-southwest line. The northeast pit, known as the Perry mine, was in operation during 1913; the other was filled with water and has not been worked for several years. From a small hole in the ground the Perry mine has been constantly enlarged until it is now 125 to 150 feet in depth. Its diameter at the surface is approximately 250 to 300 feet. Test pits have been sunk 20 to 25 feet below the bottom, and good ore has been found at this depth, with no means of telling how much farther downward it may extend. The tonnage of bauxite ore removed from this one mine runs up into the thousands. The Perry mine, in fact, has grown so large that among the plans for the future is one for the installation of a steam shovel, a novelty in a southern Appalachian bauxite mine.

The ore obtained from the Perry mine and that farther south, near the tunnel, is as a rule light in color. Some in the Perry mine is of the compound pebble variety; some is of the pisolitic and oolitic varieties, and the latter by a decrease in the number of oolites becomes what is locally known as block ore, a fairly compact light to dark olive-gray ore with scattered pisolitic and oolitic grains. It is rich in alumina and low in both iron and silica. The ore is called block ore because it breaks off from the mass in blocks. It looks like clay but crumbles in a characteristic way, quite unlike the behavior of ordinary plastic clay when similarly treated. Thus a test to show whether the material is clay or good ore may be easily performed by crushing a a small fragment between the fingers.

Except the harder lumps of roughly rounded shape, the ore below the surface of the ground is fairly soft and is readily mined with pick and shovel. The soft ore as mined contains a large percentage of water, and to save freight charges it is dried before shipping, losing approximately one-tenth to one-eighth of its weight. The hard ore contains less moisture and is separated in the pit and not dried. Only 10 per cent of the ore is of this hard grade, and it does not pay to crush and dry it. This ore brings $1 less per ton at the mines for the reason that the chemical manufacturers who use it charge this amount for crushing and drying it at the chemical factories. This hard ore is sometimes called "dornick" or "dornix."

The ore from this mine was formerly hoisted on an inclined plane but is now removed by more modern methods, as the depth of the pit has made the old method too expensive and too dangerous. The ore is shoveled into a peculiar form of bucket or skip having a capacity of 1 cubic yard provided with grappling iron attachment. The skip is hoisted vertically and moved along on a wire cable to the drier, located on the hill south of the pit. The wire cable is stretched between two towers 600 or 700 feet apart. This mine is worked during the winter as well as during the summer, but the weather is of course an important factor in regulating the time and extent of operations. The water which collects in the bottom of the pit owing to the impervious character of the material is removed by a Fairbanks-Morse pump. The clay and siliceous ore obtained during the progress of mining may be removed to one side and then hauled out of the pit on

a smooth slope well adapted for this purpose. Part of the clay impurities are disposed of in this manner.

There are on the ground two rotary driers with a capacity of 3 carloads a day. The ore in the process of drying goes through both, as they act as twins. They are about 40 feet in length, are 2½ and 3 feet, respectively, in diameter, and make 7 or 8 revolutions a minute. They are constructed of steel plate with a spiral metal blade on the inside by which the ore is worked along. The fuel used is either wood or coke. After the ore is dropped near the drier from the skip it is fed into a bucket elevator which lifts it to the upper end of the 36-inch drier. It then travels forward toward the fire in the first of the twin driers. From the lower end of this drier the ore falls into another bucket elevator, from which it is fed into the upper or higher end of the second drier. The fires are at the lower end of the first drier and at the upper end of the second drier, an arrangement adopted solely for convenience in firing, and therefore the ore travels against the flame and gases in the first drier and with them in the second.

Though the ore is not washed there is a log washer on the ground. The log washers used at bauxite mines are rather crude affairs but serve very well for the purposes for which they are designed. They consist generally of two logs to which are attached flat metal plates arranged in spiral form. As the ore moves forward and upward in the washers a stream of water flows in the opposite direction, thus removing the lighter clayey impurities. A screen at the end of the washer where the feeding takes place serves to remove the lump or hard ore, which is not washed. The capacity of the washer is 2 cars, or nearly 60 tons, a day.

The bauxite shipped from the Chattanooga district, as well as from the southern Appalachian region in general, is used in the chemical industries. For such use the maximum content in iron oxide (Fe_2O_3) allowed is 2 per cent. To obtain run of ore which will not average more than 2 per cent iron oxide it has to be mixed—that is, ore containing a larger amount of iron oxide than 2 per cent is mixed with higher-grade material containing little or no iron oxide until the iron content falls below the maximum allowed. The ore is shipped to Philadelphia and Erie, Pa., and to Cincinnati, Ohio, where it is used in the manufacture of alum and other aluminum salts. That the ore shipped from this region is of a very high grade is indicated by the following analyses of representative carload lots:

Analyses of bauxite from Missionary Ridge, Tenn.

	1	2	3	4	5	6
Insoluble	12.13	11.15	11.33	11.07	13.12	12.65
Loss on ignition	28.97	30.04	30.20	30	30.39	30.31
Alumina (Al_2O_3)	57.56	57.63	57.37	57.83	55.11	55.50
Iron oxide (Fe_2O_3)	1.34	1.18	1.10	1.10	1.38	1.34

KEENBURG, CARTER COUNTY.

Bauxite was mined at the Gibson property, near Keenburg, Carter County, northeast Tennessee, for the first time in 1912 by the National Bauxite Co. The occurrence of the ore at this place was known, however, for some years prior to the beginning of mining operations.

The mine is located about 1 mile northeast of the Keenburg station of the Virginia & Southwestern Railway, which is about 4 miles due north of Elizabethton, the county seat. Keenburg is most conveniently reached by the way of either Johnson City or Bristol, both on the main line of the Southern Railway between Bristol, Va., and Knoxville, Tenn. From Johnson City a narrow-gage line (the East Tennessee & Western North Carolina Railroad) runs to Cranberry, N. C., by way of Elizabethton. From Bristol the Virginia & Southwestern Railway runs through Keenburg, approximately a mile from the Gibson mine.

The bauxite occurs at an elevation of 2,200 to 2,300 feet on a southwest spur of Holston Mountain. Geologically it occurs in the residual clays of the Watauga shale (Cambrian), very near to or on a fault along which the Erwin quartzite, an earlier Cambrian formation, has been thrust over on the Watauga from the southeast. The general geology of this region has been mapped by Keith.[1] The development thus discloses a new bauxite occurrence of commercial importance in a locality nearly 200 miles northeast of the nearest worked deposit, which is on Missionary Ridge, near Chattanooga, Tenn., and a somewhat greater distance southwest of the deposit in Botetourt County, Va., which was described in this report for the year 1908 but has never been worked. The deposit near Keenburg is of more than ordinary interest at the present time on account of its isolated position and especially in view of the fact that similar geologic and structural conditions are found in the territory intermediate between it and the known deposits both to the northeast and to the southwest. It is in such intermediate territory that new finds of the mineral may be expected in the future, especially where the geologic and structural conditions correspond to those known to be associated with the bulk of the occurrences in the southern Appalachians.

The ore body at the Gibson mine is in the form of a large irregular deep pocket or possibly several isolated pockets. The reddish-purple or variegated clay commonly associated with bauxite is present as usual, and its removal adds greatly to the expense of mining. The clay occurs in the most irregularly shaped masses or horses and is more highly colored at the surface than it is underground, the deeper color probably being due to more thorough oxidation. The contact between clay and ore is extremely sharp in many places, high-grade ore lying in places in contact with brown or red clay. The rounded outlines of the parts of the ore bodies exposed in the progress of mining are marked. This particular deposit, or parts of it, was discovered from its outcrop and from the surface débris, which was comparatively large in amount. A great deal of the ore obtained in surface mining and the dump will probably be washed, but no washer is yet installed.

There is little or no true pebble ore or "dornick" at this mine. A little of the ore is pisolitic, but the greater part is of the oolitic variety. It is drab or gray in color, or brown where the content of iron rises above the average.

The mining operations are conducted in an open cut or pit, and, owing to the location of the deposit near or on the summit of a spur

[1] U. S. Geol. Survey Geol. Atlas, Roan Mountain folio (No. 151), 1907.

projecting from the main mountain mass, mining is carried on in steps or benches. Thus the drainage is perfect and unfavorable weather can not seriously interfere with or stop operations, as is common in bauxite mines situated so that pit mining must be practiced.

The ore is mined with pick and shovel and loaded into small tram cars, in which it is wheeled a short distance to a platform. It is rarely shot down, except where there is a large mass of hard material. From the platform the ore falls through chutes into specially designed dumping cars. These cars are constructed with V-shaped bottoms and with sides that may be raised, thus allowing the ore to fall from either or both sides as desired. The loaded cars travel down an incline to the ore bins by gravity, the weight of the descending cars raising the empties. Each car holds approximately 3 tons of ore. From the bins the ore is loaded by gravity upon wagons, in which it is hauled to the mill, located a mile away at the foot of the mountain, on a spur track from the Virginia & Southwestern Railway. The wagons in which the ore is hauled to the mill are provided with log bottoms, which allow the load to be dumped without hand shoveling. Moreover, the haul from the storage bins at the foot of the incline to the mill is down grade, which enables very large loads to be handled cheaply. The fact that most of the operations are carried on by gravity tends to decrease the cost of handling.

The mill has been built on a hillside in such a manner that here again operations are conducted largely by a gravity system. Though the initial cost of such a method of construction may be large, owing to the excavation involved, the decreased cost of handling obtained will probably more than offset it. The advantages of such construction in a bauxite mill are obvious, and no doubt the experience gained here will not be lost on those who have such mills to construct in the future, at least in places where the lay of the land admits of such procedure. The mill is located only a few hundred feet from the main line of the Virginia & Southwestern Railway and is reached by a spur track that crosses Indian Creek, so that the cars may be loaded directly.

In unloading at the mill the wagons are hauled directly on a platform at the grizzly, through which the fine ore passes to the rotary kiln drier. The ore too coarse to pass through the grizzly is deflected to a crusher. The furnace or drier is of the usual elongated cylindrical type, tilted at a slight angle so that its upper end is about 16 inches above its lower end. The material to be dried falls into the upper end, where also the fire is located, and the gases pass downward with the ore. Coke is used for fuel. A forced draft supplies air to the coke and a blower assists the passage of the heated gases through the rotating drier. This blower is in the form of a steam jet located at the cool end of the drier. The steam jet tends to keep down the temperature of the hot gases from the fire, but the moisture from the condensation of the steam does not seem to wet the ore to any appreciable extent.

Owing to the advantageous location of the mill on the hillside, 75 to 100 tons of ore a day can be handled, but at present a little less than this amount is being dried. The drier is approximately 36 feet long and 3 feet in diameter. It rotates approximately 8 revolutions a minute, the motive power being furnished by a small boiler.

GEORGIA.

HERMITAGE DISTRICT.

About Hermitage, which is 8 miles in a straight line northeast of Rome, Floyd County, Ga., is a group of bauxite mines constituting what has been termed the Hermitage district. This district may be considered to extend in a northeast-southwest direction for a distance of 10 miles, from a few miles east of Plainville, Gordon County, to a mile east of Harper, on the Southern Railway between Chattanooga and Rome. Most of the bauxite mines which have been worked in this general region are located in close proximity to Hermitage, though a few are found farther east, in Bartow County. Bauxite was revealed in this area in connection with the mining of the brown iron ores which occur in the hills east and northeast of Hermitage. These ores were hauled to Hermitage (then Ridge Valley) and reduced in an old charcoal iron furnace which long ago fell into disuse. The writer is informed that the first bauxite mined in the southern Appalachians came from this vicinity and was mined by the Republic Mining & Manufacturing Co., the pioneer in the business.

The many old pits in this region indicate the great scale on which bauxite mining has been carried on in the past. It is thought that considerable supplies of good ore still remain, together with a large amount of low-grade ore which it will not pay to work under present econom c conditions, but which will no doubt prove of value when some cheap process of preparing pure alumina from bauxite-bearing clays is placed on a commercial basis. Very few mines are now operated in this district. About 2½ miles east of Hermitage ore was shipped from the Hardee mine in 1913. In fact, this was the only mine operated in this immediate vicinity that year. The pit is perhaps not more than 25 feet deep and has yielded to date about 3,000 tons of ore. The surface is stripped to an average depth of about 10 feet, but in places ore appears at the surface and no stripping is needed. In the mining operations, when ore and clay are found badly mixed the ore is picked out with pickaxes. Unusually large clay masses are, however, shot out with ordinary black powder.

At the Julia mines, in Bartow County, no actual mining is in progress, but considerable old ore is being dried. Both the Julia mines are abandoned and are now filled with water. The old tracks have been torn up and the bulk of the machinery is removed. After being dried the ore is hauled to and shipped from Halls station (Linwood post office), on the Western & Atlantic Railroad about 6 miles to the southeast. It was estimated when the property was visited in May, 1913, that work at the Julia mines would be ended during the following summer. There was considerable dirty ore at the mine which it was thought might be washed, dried, and thus saved. Even if this were done it was not thought that the life of the property would be extended beyond the fall of 1913. Some prospecting has been done on the Braden place, 3 miles south of Hermitage, where good ore has been found.

Nearly all the work on bauxite in the Hermitage district has been done by the Republic Mining & Manufacturing Co. The ore mined has been dried at Hermitage before shipment. The drier has been in operation until recently, but was closed when the writer visited the locality in May, 1913. The old Watters mine, which has been an

important producer in this district, is now inactive. The ore from this mine was shipped from Harper, a station on the Southern Railway between 4 and 5 miles northeast of Rome.

Most of the other bauxite mines in this region have been closed a long time and may never be worked again, at least while present commercial conditions exist. The original pits are now filled with water and much of the surrounding clay or soil has slumped into them. Some of these mines are the Holland, Holland Springs, Church, Holland Hill, Julia, Watters, Armstrong, Stockade, No. 103, No. 104, Pine Spring, Maddox, Holland House, Ward, and Hardee. The ore from all these mines except the Julia was dried at Hermitage and was shipped from Shannon, on the Southern Railway. A bauxite mine is reported to have been opened on the mountain 2½ miles east of Plainville, Gordon County.

The ore shipped from this district is nearly all alum ore, though there is some aluminum ore in the district, the proportion of the former to the latter being about 10 to 1. The mines are usually leased by the operators for a period of years, and when they are not operated a stipulated sum per month is generally paid. When ore is being mined a certain royalty is paid, usually 25 to 75 cents a ton, the rate depending on the distance of the mine from the railroad. In most places the ore is hauled to the railroad in wagons with a capacity of 3,800 to 4,000 pounds of dried ore.

ROME DISTRICT.

The Aluminum Co. of America has done some work recently at Booger Hollow, south of Rome. After the removal of a considerable quantity of ore work stopped and has not been resumed since. During the year 1913 prospecting was done in the immediate vicinity by persons from Rome, and what may prove to be an important deposit of the mineral has been revealed by numerous shallow pits dug during the exploratory work. This property is located about 10 miles southwest of Rome or about 4 miles south of Sixmile, a station on the Southern Railway, and is not more than 2 miles from the Floyd-Polk County line. Southeast of the Booger Hollow prospect are the Tombstone, Burkhalter, and Henry prospects.

Near Reesburg, about 3 miles east of Booger Hollow, bauxite has been developed by surface exploration. On the Fountain property, 12 miles southeast of Rome on a direct line between Rome and Cartersville, a short distance southeast of Ligon, Bartow County, a large tonnage of bauxite has been reported blocked out. It is said that considerable white ore is present and that a washer will have to be used in preparing the ore for shipment.

BARTOW COUNTY.

The Cherokee Bauxite Co. is working at the Curtis mine, about 3 miles east of Halls station (Linwood post office), on the Western & Atlantic Railroad midway between Kingston and Adairsville. The mine is an open pit several hundred feet in length and rather shallow, being not over 50 feet deep at the deepest place. Considerable prospecting has been done immediately to the east, and good ore has been developed which may possibly be a continuation of the ore body now being mined. White clay or kaolin has also been found in the immediate vicinity.

The ore is loosened in the mine with either powder or dynamite. For surface blasting powder is generally used, but in the ore itself dynamite is most commonly employed to avoid scattering the loosened material. After the ore is mined and placed in the mine cars it is hauled up the low incline and along a narrow-gage track to the mill by means of wire cable (the motor power being steam), and dumped into a hopper, from which it falls to the drier floor. From the ore pile thus formed it is shoveled into a bucket elevator, from which it falls into a spout and then into the upper end of the drier. From the lower end of the drier it falls into a bucket elevator that leads it to storage bins provided with chutes for loading the wagons. The fuel used in the drier is wood or coke, the latter having been found to be very satisfactory. Coal is burned under the boilers.

There are other bauxite mines in this region—for example, the Warner, which is nearly worked out. This mine is located 1½ to 2 miles southeast of Halls station. Other good prospects have been opened in the vicinity of the Curtis mine and it is expected to obtain ore from them in the future. It is not known when work will begin on those located a short distance west of the present workings, as the company is more interested in extending operations to the east.

ALABAMA.

In the Rock Run district, Cherokee County, Ala., the Monahan mine was worked by the Republic Mining & Manufacturing Co. during the year. The ore is hauled out of the mine in small ore cars on an inclined plane and is dried before it is shipped. The pit at the surface is 250 to 280 feet in longer diameter and 75 feet in shorter diameter and it tapers roughly to 50 feet at the base. It is fairly deep. The red bauxite from this mine is shipped to the Aluminum Co. of America. The white ore is sold by the Republic Mining & Manufacturing Co. for use in the manufacture of alum. The overburden at this mine ranges in thickness from 10 to 20 feet.

Other mines in the vicinity of Rock Run which have been worked during past years are the Dykes, Warwhoop, Tomahawk, and Klondike. On the Dykes property a mine known as the New Dykes has recently been in operation.

The White Bauxite Co. has done some work in the last few years near Forney, Ala. On account of the poor grade of the ore the work on the bauxite has been suspended and the company is now engaged in mining iron ore, which is shipped to the furnace of the Bass Foundry & Machine Co. at Rock Run. The great bulk of the bauxite mined in this region enters the chemical trade.

THE PRODUCTION OF ALUMINA FROM CLAY.

Though new bauxite deposits are being found from time to time and though the present demand does not appear to tax unduly the known supply of the lower-grade material, the interest now being taken in the preparation of pure alumina from clay or other silicate minerals is worthy of note. As soon as a process for the extraction of alumina from clay is put on a commercial basis, large quantities of low-grade bauxite containing considerable admixtures of clay will become available. That there is a large tonnage of such material associated with most of the southern Appalachian bauxite is well

known. This material should first be tested before the nonbauxitic clays containing the smallest amounts of alumina are utilized.

The Cowles process[1] of manufacturing alumina was outlined in this report for 1912. As it still continues to attract considerable attention as a possible source of alumina, it will be outlined again here. In this process clay, carbonaceous matter in the form of either charcoal or sawdust, and salt are made into perforated briquets, which, after being dried in a kiln, are passed in flat cars through a long furnace which raises their temperature to about 1,035° C. Steam is blown into the discharge end of the furnace, while through the other end the loaded cars are gradually moved forward by a hydraulic pusher. The speed is under control. The weight and composition of the material on the cars are known, and the correct amount of exhaust steam is passed into the furnace from the opposite end. The gases are sucked from the charging end and forced through a condensing system. The reaction which occurs varies according to the composition of the mixture, but sodium silico-aluminate and hydrochloric acid are the valuable products formed. The latter is condensed and saved. Any iron present in the clay is condensed as iron chloride in the first condenser of a multiple-series system. The acid produced is pure. To 1 ton of salt in the charge about 1.75 tons of 33 per cent acid are produced.

The sodium silico-aluminate, which is acid in reaction, is next treated to obtain the sodium aluminate from it. The calcined briquets are ground and treated with enough lime to combine with the silica to form dicalcium silicate. The chemical equivalent of limestone, calcite or marl, may be used instead of anhydrous lime. The mixture of lime and acid salt is heated in a furnace just to the clinkering temperature. On being discharged it is broken up and leached. Nearly all the sodium aluminate may be leached from the clinker; the residue is a mass of dicalcium silicate containing some sodium aluminate. The method of procuring alumina and caustic soda from the solution is the one in general use. The dicalcium silicate with one molecular weight more of lime is of use in light-gray cement mixtures or as material for glass making.

The process outlined opens the way to obtain alumina cheaply or as a by-product with other products which are consumed on a large scale in the industries. Cowles believes that with the introduction of the process the cost of production of metallic aluminum will be reduced to 4 or 5 cents a pound.

THE SERPEK PROCESS OF PRODUCING ALUMINA AND AMMONIA.

The Serpek process deals primarily with the fixation of nitrogen. It involves also the production of alumina as a by-product, and hence is of interest in the present report. This by-product will probably prove of importance to the commercial success of the process. The raw material is bauxite, and thus the process involves a purification of this mineral. The pure alumina formed by this process is not used again in the fixation of the nitrogen, as it requires a higher tem-

[1] Eighth International Cong. Applied Chem., Orig. Comm., vol. 25, pp. 119–124. See also patents Nos. 1040892, 1040893, 1040894, 1040895, and 1040897, all dated Oct. 8, 1912. See also paper read at the joint meeting of the American Electrochemical Society, American Chemical Society, and Society of Chemical Industry, Chemists' Club, New York, Feb. 7, 1913 (printed in Jour. Ind. and Eng. Chemistry, April, 1913, pp. 331–335).

perature to combine with nitrogen than bauxite. The reaction is $Al_2O_3 + 3C + 2N = 2AlN + 3CO$.

In the experiments which Serpek carried out he found that at temperatures of about 1,800° to 1,850° C. alumina, when mixed with carbon and subjected to an atmosphere of nitrogen, rapidly formed aluminum nitride, and that compounds such as bauxite would give the reaction at a slightly lower temperature. In practice he uses two rotating cylindrical kilns into the upper of which bauxite is fed and calcined. In the passage from the upper to the lower kiln the bauxite is mixed with carbon, and in its passage through the lower kiln it passes an electrical resistance by means of which the temperature is maintained at 1,800° to 1,900° C. The nitride which is produced here is discharged into an air-tight chamber. The nitrogen which brings about the reaction is produced in a gas producer, and the mixture of nitrogen and carbonic oxide there evolved passes in the opposite direction to the descending material. The carbonic oxide is subsequently mixed with air and is burned in the upper kiln, effecting thereby the calcination of the bauxite. Contact of the aluminum nitride with water produces ammonia and alumina, and in practice aqueous solutions of acid would be used for producing a soluble form of ammonium compound. It will be observed, therefore, that the process yields a pure alumina suitable for the manufacture of metallic aluminum and an ammonium fertilizer, the nitrogen in which is drawn from the atmosphere. It is reported that the process is being developed in France.

USES OF BAUXITE.

The chief uses of bauxite were outlined in this report for 1912, as follows: (1) As raw material in the production of metallic aluminum; (2) in the manufacture of aluminum salts; (3) in the manufacture of bauxite bricks; (4) in the manufacture of alundum (fused alumina) for use as an abrasive. The use of bauxite in the manufacture of calcium aluminate to give a quick set to plaster compositions should be added, as well as the extended use which alundum is finding in the refractory industries. The two latter uses are described briefly further on.

1. The use of bauxite in the production of metallic aluminum is by far the most important of those enumerated above. A large part of the entire output of Arkansas is used in the metallic aluminum industry, and the figures of production from this State have shown phenomenal growth during recent years. A large part of the French product is also used in the manufacture of metallic aluminum.

2. Only the purer bauxite is used in the manufacture of chemicals, such as alum, aluminum sulphate, and aluminum salts in general. Freedom from oxide of iron is essential in the material to be used in the chemical manufactures.

3. The use of bauxite in the manufacture of bauxite brick for furnace linings has long been considered. It has been found by experiment that when the impure forms containing considerable iron oxide are exposed to intense heat the bauxite is converted into a solid mass of emery of such extreme hardness that it can barely be cut by steel tools and that it resists chemical, thermal, and mechanical action to

a marked degree. The purer the bauxite used the more refractory it is, and the addition of bauxite free from iron oxide to refractory clays increases their alumina content and at the same time their refractoriness.

The high cost of the raw material, as well as of the manufacture of the bricks, makes the ultimate cost of bauxite brick high compared with the cost of silica or fire-clay brick.

Recent applications of bauxite in brick are in the lining of rotary cement kilns, lead-refining furnaces, and basic open-hearth steel furnaces, where a brick high in alumina and low in silica is required. Recent tests seem to show that bauxite brick are suitable for basic open-hearth furnaces, provided they can be made with less than 12 per cent silica; and experiments show that bricks with this low proportion of silica are as good as magnesite brick.

In preparing bauxite for use in kiln or furnace linings, the crude ore is first washed to remove some of the free silica and clayey impurities. It is next calcined at a temperature of 2,500° F., and during this process it gives off its water of constitution, amounting to about 30 per cent of the raw ore, and undergoes great shrinkage in the meantime. In the calcination of bauxite according to modern methods rotary kilns are employed in which oil, gas, or powdered coal are used as fuel. The kilns should preferably be installed at the mines in order to save the cost of transportation of the large content of water present in the crude ore. It has been observed that the bauxite shrinks very little below a temperature of 2,390° F. Between this temperature and 2,500° F. the greatest shrinkage takes place. Accordingly, the lowest temperature at which bauxite should be calcined is about 2,500° F.

The calcined mineral may be bonded with fire clay, sodium silicate, or lime. As little as 4 per cent of plastic fire clay may be used as a bond in hand-made brick. When bonded with lime the brick become so hard a few hours after making that they will not take the impression of the finger nail. This setting or hardening is probably due to a reaction between the lime and the free silica whereby calcium silicate is formed, and the reaction may be analogous to that involved in the setting of silica brick when bonded with lime. After a careful drying the brick are burned in down-draft kilns at a high temperature, becoming hard and tough. A brick 9 by 2½ by 4½ inches weighs 7½ pounds and stands a crushing test of 10,000 pounds to the square inch.

According to Kenneth Seaver [1] the early troubles in the use of bauxite brick were due largely to deficiencies in the bonding material, to insufficient calcination of the raw stock, and to the attempt to burn the bricks at too low temperatures. A high-grade bauxite brick should run 56 per cent of alumina, or still higher where conditions warrant. The term bauxite brick is somewhat loosely applied, and the alumina content varies within considerable limits, many of these brick containing only 43 to 51 per cent of alumina. If properly made the brick is physically strong and tough, but has a tendency to spall in the arches if suddenly cooled or heated. A representative analysis of bauxite brick is given on the next page.

[1] Eng. Soc. Western Pennsylvania Proc., vol. 29, No. 6, pp. 342–343, July, 1913.

Analysis of bauxite brick.

Silica (SiO_2)	38.38
Alumina (Al_2O_3)	56.77
Iron oxide (Fe_2O_3)	2.95
Lime (CaO)	.00
Magnesia (MgO)	1.09
Alkalies	.88
	100.07

4. Bauxite is used on a large scale in the manufacture of the artificial abrasive, alundum, at Niagara Falls. This abrasive is made in the electric furnace by fusing calcined bauxite. It is high in crystalline aluminum oxide and virtually amounts to a form of artificial corundum. Its quality is under complete control, and hence it can be duplicated with ease in the various abrasive products, a factor of great importance in any successful abrasive industry. Alundum is particularly efficient in the grinding of steel.

5. Lastly should be mentioned the application of bauxite in the manufacture of calcium aluminate to give a quick set to plaster compositions. For a full description of the use of bauxite in calcium aluminate the reader is referred to Mineral Resources for 1911.[1]

ALUMINUM.

PRODUCTION.

The magnitude of the aluminum industry is shown in the following table, which gives the production since the beginning of the industry in 1883 and the domestic consumption of the metal since 1904.

Production, in pounds, of aluminum in the United States, 1883–1913.

1883	83	1894	550,000	1905	[2] 11,347,000
1884	150	1895	920,000	1906	[2] 14,910,000
1885	283	1896	1,300,000	1907	[2] 17,211,000
1886	3,000	1897	4,000,000	1908	[2] 11,152,000
1887	18,000	1898	5,200,000	1909	[2] 34,210,000
1888	19,000	1899	6,500,000	1910	[2] 47,734,000
1889	47,468	1900	7,150,000	1911	[2] 46,125,000
1890	61,281	1901	7,150,000	1912	[2] 65,607,000
1891	150,000	1902	7,300,000	1913	[2] 72,379,000
1892	259,885	1903	7,500,000		
1893	333,629	1904	[2] 8,600,000	Total	377,737,779

The secondary aluminum produced in 1913 was 2,198 short tons; the quantity of recovered aluminum contained in alloys was 2,456 short tons.

EXPORTS.

The value of exports of aluminum and of manufactures of aluminum of domestic production for the last five years has been as follows:

Exports of aluminum of domestic production, 1909–1913.

1909	$567,375	1912	$1,347,621
1910	949,215	1913	966,094
1911	1,158,603		

[1] Phalen, W. C., Bauxite and aluminum: U. S. Geol. Survey, Mineral Resources for 1911, pt. 1, p. 931, 1912.

[2] Consumption. The figures for 1913 do not include the weights of imported leaf aluminum, valued at $1,228; table, kitchen, and hospital utensils, valued at $40,947, and "All other manufactures" of aluminum, valued at $353,844.

EXPANSION OF THE ALUMINUM INDUSTRY.

SOUTHERN ALUMINUM CO.

The Southern Aluminum Co. has vigorously pushed operations on its project on Yadkin River near Whitney, N. C., in 1913. Whitney is located on a branch line of the Southern Railway running out of Salisbury. It is also on the Winston-Salem Southbound Railway, a line connecting at Winston-Salem with the Norfolk & Western Railway, which runs to Roanoke, Va., and Hagerstown, Md., thus furnishing an outlet to the north.

At the time the Southern Aluminum Co. purchased the old Whitney dam of the North Carolina Electric & Power Co. it was the plan to complete the latter company's plant. When it was found, however, that the power generated from this source would not be adequate for the Southern Aluminum Co.'s needs, the plan was given up and a new dam site 5½ miles farther down the river was selected. At the point chosen Yadkin River contracts to less than 100 feet and the stream rushes through the narrows with considerable velocity. The underlying reason for the narrows is a change in the character of the rock from soft but massive shales to a tough greenstone (amphibolite).

The plans of the company contemplate the erection of a dam approximately 1,200 feet long and more than 200 feet high. It will be 20 feet wide at the top and 155 to 160 feet wide at the bottom, and will contain manholes placed vertically and laterally so as to assist in the location and repair of leaks. It will be built with a considerable curve. It is expected that more than 100,000 horsepower can be generated here, but that in normal condition of the water less than this amount will be developed. The backwater from this dam will cover a broad area, estimated at about 6,000 acres. It was expected that the work of placing the concrete would be begun by February or March, 1914.

Construction on the various projects connected with the work is being actively pushed. Two tunnels are to be driven above the east end of the dam through the solid amphibolite. Each tunnel will be nearly 1,000 feet long, 35 feet high, and 45 feet wide, and they will be separated by a 15-foot pillar of the solid rock. When they are completed a cofferdam will be thrown across the river, which consequently will be diverted through the hill while construction work on the main dam is in progress. The tunnels are to be fitted with gates and will be used to carry off the flood water or to drain the pond to admit of repairs to the dam.

The plans also contemplate a power house to be built of reinforced concrete. The reduction works will be near by, but the electrode works and laboratory for preparing pure alumina will be some distance to the west. The plans also contemplate a village, to be called Badin, laid out in model fashion with residences for engineers and laborers, a public square for stores, churches, etc.

To carry on this work a large trackage of standard-gage railroad has been built by one of the contracting companies. A complete plant for the manufacture of crushed stone and concrete is in process of erection. A score or more of steel derricks have been erected and an air-compressing plant of large capacity, hoisting engines, loco-

motive cranes, dump and flat cars, steam shovels, drills for outside and tunnel work, etc., are at hand.

During the early stages of manufacture of aluminum the alumina will be imported, as the reduction plant for making the metal will be ready to operate before the laboratory in which the pure alumina is to be made is complete. Imported bauxite may be used during the early stages of the enterprise, or at least until an adequate supply of the proper ore is located in this country. The placing of bauxite on the free list will work to the advantage of the company. At the beginning only ingot metal will be made, but it is very likely that in time wire, vessels, and other finished forms will be manufactured.

ALUMINUM CO. OF AMERICA.

The Aluminum Co. of America is pushing exploratory work on Little Tennessee River near the boundary between Tennessee and North Carolina with a view to the final selection of two dam sites. The headquarters of the company are at Alcoa, about 50 miles south of Knoxville and 6 miles from Chilhowee, the nearest railroad point. Alcoa is located at the mouth of the gorge of Little Tennessee River, where the stream enters a broad and beautiful flood plain, once the scene of quiet farm life but soon likely to be changed by the advent of an important manufacturing industry. Camps for laborers and engineers have been built along the edges of the flood plain and in the vicinity of the projected dam sites farther up the river. The bed of the river has been tested with the diamond drill, and exploratory work is in progress to test the thickness of the mantle of débris where the lateral foundations of the dams are to be placed.

One of the dam sites will be on Little Tennessee River in Tennessee a few miles above Alcoa. The other site is about 9 miles above Alcoa, at the mouth of Cheowah River, in North Carolina. Both sites are in the deep V-shaped gorge of the Little Tennessee, which here runs through the Great Smoky Mountains. Both sites are also in the rocks of the Great Smoky conglomerate, which in this region consists of conglomerates, sandstones, and gritstones, with a few beds of slate, all in places more or less metamorphosed and for the most part of a resistant character.

The hydroelectric power which will be developed at the dams will be transmitted to Maryville, where a reduction plant is to be built. The plans of the company contemplate an installation which will yield 100,000 horsepower.

At the plant of this company at Massena, N. Y., extensive additions and improvements have been in progress during 1913. The works are located outside of the town of Massena, which is about a mile north of Massena Springs, the terminus of the Grand Trunk Railway from Montreal and the north and of the New York Central & Hudson River Railroad from the south. The Aluminum Co. has been located here about 10 years. Among the improvements in progress are a new office building and extensive additions to the mill and power plant. At Massena the company confines itself to the manufacture of aluminum ingots of different sizes, billets, reinforced aluminum wire cables for long-distance transmission, and nonreinforced wire cables. Extruded shapes and molded pieces are not made here but at the plant at New Kensington, Pa. The company is

said to have contracted for a large supply of electricity from the power development at Cedar Rapids on St. Lawrence River.

Several additions to the New Kensington plant were made during the year, old buildings being replaced by new ones and additions being made to those already built. The bronze-powder department has finished its first year of production on a large scale. A large aluminum-foil rolling mill is nearing completion at Arnold, Pa. The uses of metallic aluminum for bronze powder and aluminum foil were described at some length in this report for 1912.

THE ALUMINUM MARKET.

The prices per pound for No. 1 ingot metal at New York City during 1913, generally for spot metal rather than metal for future delivery, are stated below.[1]

Toward the end of December, 1912, the price of metallic aluminum was 25½–26 cents a pound. During the early part of January, 1913, the market was only slightly active with quotations at 26–26½ cents. Toward the end of January the demand improved slightly and as a result the market became more active, but prices again declined to 25¾–26 cents in early February, and remained at these figures throughout the month. The pressure for deliveries on contracts in March caused a progressive rise during the month, from 26–27 cents a pound in early March to 27¼–27¾ cents in early April. Supplies then became a little better and prices grew easier, and though the demand was good in the first half of the month it became quiet toward the end, with prices at 26¾–27 cents during late April and early May. During early May the market was not at all active, and prices were 26¼–26¾ cents. Business picked up toward the end of the month, however, but quieted down again in early June, when prices for spot metal were 25½–26 cents. The market continued quiet, and toward the middle of June there was a decline which continued to the end of the month, when prices reached 23½–24 cents. The market conditions remained somewhat unsettled, but during the greater part of July prices remained fairly steady, ranging from 23¼–24 cents early in the month to 23–23½ cents at the middle. At the end of the month sales were made on a larger scale, and prices were 23¼–23¾ cents. The improvement was only short lived; sales became lighter and prices slumped to 23–23½ cents. The uncertainty of the tariff situation apparently affected business to some extent, and only the metal required for immediate use was purchased. Prices declined gradually during August and at the end of the month were only 22–22½ cents. These figures were maintained, but with a dull market, throughout September. The tariff act approved October 3, 1913, placed a duty of 2 cents a pound on aluminum, aluminum scrap, and alloys in which aluminum is the component metal of chief value in crude form, and of 3½ cents a pound on aluminum in the form of plates, strips, bars, sheets, and rods. Quotations fell in October to 20–20½ cents, where they remained throughout the month, with a quiet market and few sales. The market was also dull throughout November, the average price being about 19½ cents. Reports from Detroit were to the effect that none of the large automobile companies were running at over 50

[1] Quotations for this and the preceding years have been taken from the Engineering and Mining Journal.

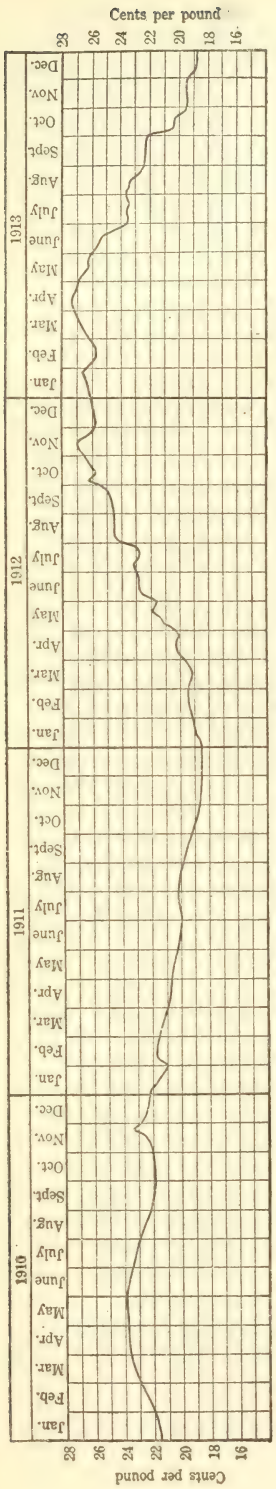

FIGURE 1.—Curve showing price at New York City, by months, 1910–1913, of metallic aluminum in the form of No. 1 ingots.

per cent of their capacity and that some were operating on an even smaller scale. In early December quotations were at $18\frac{3}{4}$–$19\frac{1}{4}$ cents, with the market still weak and only slight demand. Near the end of the month prices went still lower, to $18\frac{1}{2}$–19 cents, and these prices were quoted into January, 1914.

The figures given above are presented in more concise form in the table given below and their fluctuations are illustrated graphically in figure 1. It is of interest to observe the broader fluctuations in the price of metallic aluminum and to note the return at the beginning of 1914 to the same price level which existed at the beginning of 1912.

Average price of metallic aluminum at New York City in 1913, in cents per pound.

January	$26\frac{1}{8}$–$26\frac{5}{8}$
February	$25\frac{4}{5}$–$26\frac{1}{8}$
March	$26\frac{5}{10}$–$27\frac{2}{10}$
April	27 –$27\frac{3}{8}$
May	$26\frac{3}{10}$–$26\frac{3}{4}$
June	$24\frac{3}{4}$–$25\frac{1}{4}$
July	$23\frac{1}{8}$–$23\frac{1}{5}$
August	$22\frac{7}{10}$–$23\frac{2}{10}$
September	22 –$22\frac{3}{8}$
October	20 –$20\frac{6}{10}$
November (first half of month)	$19\frac{1}{2}$
November (last half of month)	$19\frac{1}{6}$–$19\frac{3}{5}$
December	$18\frac{7}{10}$–$19\frac{2}{10}$

NEW USES OF METALLIC ALUMINUM.

The employment of metallic aluminum in the manufacture of cooking utensils and other articles of domestic use has been referred to in Mineral Resources in previous years. The use of the metal is now being extended on a much larger scale, as in the construction of welded tanks, cooking vats, and vessels which are employed by brewers, preserve manufacturers, fat recoverers, and in similar industries where a metal that will conduct heat, will not corrode, and is not poisonous is essential. There has been an increased demand for large steam-jacketed vessels in the canning industry and in hotels and institutions of various kinds. These cooking utensils have been tested to ascertain if food was in any way injured by being prepared in them. It was found as a result of these experiments that the only substances which dissolved any of the

metal were oranges, lemons, Brussels sprouts, and tomatoes, and in every case the quantity dissolved was so small as to be harmless.[1]

Other uses for aluminum vessels on a large scale are in the manufacture of essences and sirups, varnishes, fatty acids, edible oils, and nitric acid. Aluminum storage tanks are said to be well adapted for containing extracts, essences, and essential oils, being highly resistant to the acids contained in these substances. Other advantages are that they are cheaper than copper and are light, clean, and unbreakable. A large number of firms abroad are using aluminum in the varnish-making industry. In addition to giving improved color, the metal is said to be particularly resistant to the heat and action of the fire gases. It has also been proved to be durable under the conditions of high temperature, pressure, and vacuum encountered in the manufacture of fatty acids and edible oils, and its use is said to result in a product free from taste and color. Welded aluminum tanks are now being employed for obtaining and measuring acid and for piping and conveying the acid in the works. A number of aluminum tank cars have been made for the conveyance of strong nitric acid in bulk and the results have been satisfactory.

The use of aluminum wire as a conductor in long-distance power-transmission schemes is not new and has been referred to in this report in previous years. The use of insulated aluminum cables, however, is of some interest, especially as the Paris Omnibus Co. has placed a large contract for aluminum-armored cables for tramway-feeder networks. The cables will have cross sections up to 1.55 square inches and are to carry a current of 500 volts. An order which it is reported was placed in 1913 comprises about 300 tons of metal and it is expected that the aluminum will show an economy of 8 to 10 per cent compared with the cost of copper cables. Including cables already installed with a net weight in aluminum of about 300 tons, there are in service or under order insulated cables employing a total of 600 tons of aluminum in this company's system.[2]

A recently developed branch of the aluminum industry is the manufacture of the powdered metal known to the trade as aluminum-bronze powder, which is used extensively as a paint pigment, in explosives, in lithographing, and in printing. To make the powder, aluminum foil only 0.01 millimeter (0.0004 inch) thick is cut into squares of 2 millimeters (0.079 inch) on a side and rubbed to powder. The material feels like powdered graphite and is just as difficult to remove from the skin. As noted in the descriptions, this department of the Aluminum Co. of America's plant at New Kensington, Pa., has recently completed its first year of production on a large scale.

Aluminum foil, though not exactly a new product, is now being used on a larger scale than ever before, owing to improved methods in its manufacture after long and expensive experiments which have reduced its cost appreciably. The rolling is reported to be effected in six stages, the last of which yields a foil 0.04 millimeter (0.0016 inch) in thickness. In order to get a thinner foil several sheets are laid together and either rolled or beaten like gold leaf. It is reported that foil as thin as 0.00025 inch will be rolled for special purposes at the plant of the Aluminum Co. of America at Arnold, Pa. Alumi-

[1] The Metal Industry, vol. 11, No. 12, p. 510.
[2] Daily Cons. and Trade Repts., Apr. 25, 1913.

num foil has partly displaced tinfoil for wrapping articles such as cheese, chocolate candies, and tobacco. It is also reported to be used in the manufacture of electric condensers.

The employment of metallic aluminum in the manufacture of articles of everyday use has become so common that such articles no longer attract attention as novelties. One of the newest and perhaps oddest uses that has come to the writer's attention during the year is the employment of aluminum in making the soles of shoes to be used by workmen employed in wet and damp places. The aluminum-soled shoe lasts much longer than an ordinary shoe and is said to be impervious to dampness.

PROCESS OF EXTRACTING ALUMINUM FROM ITS ORES.

Alan Kissock has patented a process (U. S. patent No. 1052727, February 11, 1913) for extracting aluminum from its ores, of which the silicate is taken as an example, as follows: The charge consists of a mixture of any suitable aluminum-bearing material with enough carbon to convert the aluminum to the carbide and the proper amount of some sulphur compound or sulphur to convert the aluminum carbide to the sulphide. This charge is put into an electric furnace of suitable design and heated. The resulting aluminum compound is separated, dissolved, and electrolyzed in a molten bath of alkaline earth chlorides or fluorides and the resulting metallic aluminum is drawn off.

A particular aluminum compound as well as other specific ingredients, together with the proper proportions for mixing them, are described in the patent, though stress is laid on the point that the invention is not limited to these proportions or these ingredients. For example, the charge may consist of an intimate mixture of aluminum silicate or carbon in the form of coke. This charge is placed in an electric furnace of suitable design and heated to a temperature of about 3,500° C. The aluminum carbide formed is separated from the rest of the mass and heated with sulphur. The resulting aluminum sulphide is then dissolved and electrolyzed in a molten bath of alkaline-earth chloride or fluoride and the resulting aluminum drawn off. An alternative charge consists of an intimate mixture of aluminum silicate, carbon in the form of coke, and calcium sulphide. This charge is heated to a temperature of about 3,500° C. in an electric furnace and the aluminum sulphide formed is separated, dissolved, and electrolyzed as before. The proportions of the ingredients which may be used, together with reactions, are given in the text of the patent.

THE ALUMINUM INDUSTRY IN FRANCE.

An interesting summary of the present status of the manufacture of aluminum in France is given in La revue électrique of September 5, 1913. According to this account five French companies are producing metallic aluminum. These are (1) the Société électrometallurgique française, (2) the Compagnie des produits chimiques d'Alais et de la Camargue, (3) the Société des forces motrices et usines de l'Arve, (4) the Société des produits électrochimiques et électrometallurgiques des Pyrénées, and (5) the Société d'électrochimie.

These five companies have formed another company, L'aluminium français, which acts as a sales agent, does research work on the applications of aluminum, and carries on a propaganda to encourage its greater consumption. This company also manufactures, in its plants at Selzaute, Belgium, and Mennessis, France, considerable quantities of alumina, sulphate of aluminum, etc. It is now erecting at Arrean, in the Pyrenees, an aluminum factory and at Chambery, Savoy, a rolling mill for the manufacture of aluminum sheets, etc. At Kremlin-Bicetre, near Paris, it has a factory for making tubes, etc. The present status of the five constituent companies is briefly:

The Société électrometallurgique is Paul Héroult's company, formed in 1888, the oldest of the French electrometallurgical companies. Its capital is 15,500,000 francs. In the different plants of the company at Froges, La Praz, St.-Michel-de-Maurienne, and L'Argentiere 65,000 to 70,000 horsepower is available during the greater part of the year. Besides aluminum ingots, bars, wire, cables, tubes, aluminum cooking utensils, and pure alumina, the company produces ferroalloys, electric steel (Héroult process), and carbon electrodes.

The Compagnie des produits chimiques d'Alais et de la Camargue was founded in 1855, and its capital is now 10,500,000 francs. Its plant at Salindres was originally intended to manufacture soda by Le Blanc's process, but later was devoted successfully to chlorine manufacture, and began, in 1861, to produce aluminum by the purely chemical process of Henri Ste.-Claire Deville. For 30 years it was the sole producer of aluminum in France. In 1897 it bought the Calypso aluminum plant, and later equipped another hydroelectric plant, now producing considerable quantities of aluminum.

The Société des produits électrochimiques et électrometallurgiques des Pyrénées was founded in 1906 and has a capital of 6,000,000 francs. Its Auzat plant has a capacity of 16,000 horsepower, and its output is 6 tons of aluminum, 9 tons of chlorates or perchlorates, and 10 tons of calcium carbide or ferroalloys daily.

The Société des forces motrices et usines de l'Arve was founded in 1895 and has a capital of 4,100,000 francs. Its Chedde plant has a capacity of 22,000 horsepower, and its maximum output is 6 tons of aluminum and 20 tons of chlorates and perchlorates per day.

The Société d'électrochimie was founded in 1889 by Gall and De Montlaur for the electrolytic production of potassium and sodium chlorates and has a capital of 10,000,000 francs. In its numerous plants the company produces chlorates, aluminum, calcium, and calcium hydride, potassium and sodium cyanides, and other chemical products.

ALLOYS.

To make aluminum harder and stronger and to impart to it better wearing properties, at the same time keeping its valuable lightness and color, it is alloyed with small percentages of such metals as manganese, zinc, tin, copper, and nickel.

According to C. H. Ivinson[1] the alloys of aluminum are much more important than the pure metal in general engineering work.

[1] Paper read at annual convention of British Foundryman's Association in London, June 21–24, 1913. Printed in Metal Industry, vol. 11, No. 8 pp. 340–341, August, 1913.

Aluminum forms alloys with every known metal, the union being accompanied by disengagement of heat. It is particularly active in combining with copper. Most of the alloys are chemical combinations rather than mechanical mixtures, but lead, antimony, and mercury, for example, are exceptions, as these metals do not alloy very easily with aluminum.

The useful alloys of aluminum fall into three groups, (1) aluminum containing not more than 10 to 25 per cent of added metals, (2) metals containing not more than 10 to 15 per cent of aluminum, (3) alloys of rare metals with aluminum containing from 0.5 to 5 per cent of added metal.

COMMON ALLOYS OF ALUMINUM.

Among the best known of the commoner alloys of aluminum is one which contains 4 to 10 per cent of copper. Others are the aluminum-zinc alloys containing from 8 to 30 per cent of zinc. Zinc is the cheapest known hardener of aluminum and in quantities up to 15 per cent increases its rigidity and strength. Tin when alloyed alone with aluminum appears to develop brittleness, and alloys of aluminum and 15 per cent of tin have been known to disintegrate entirely in the course of a few days. Nickel added by itself to aluminum produces unstable alloys. An alloy containing 4 per cent of nickel has been shown to disintegrate soon after being cast, but the introduction of a third element such as copper is an advantage. Phosphide of copper to the extent of 1.5 per cent added to a zinc-aluminum alloy containing from 12.5 to 15 per cent of zinc gives fluidity to the molten metal. Phosphide of zinc containing 25 per cent of phosphorus may be substituted in the proportion of 0.05 per cent. According to Ivinson this is one of the best fluxing and cleansing agents for aluminum alloys and should be added to the molten alloy a few minutes before pouring by wrapping in paper and plunging to the bottom of the crucible by means of tongs with brisk stirring.

Magnesium-aluminum alloys containing from 1 to 10 per cent of magnesium are improved by the addition of 5 per cent of zinc, which imparts better wearing properties to the metal and aids in producing homogeneous castings. By adding 1 per cent of phosphide of copper less oxidation of the metal takes place during the melting.

The alloys of copper, nickel, magnesium, and zinc have tensile strength when newly made, but in the course of time chemical and electrolytic action render some of them very brittle and may lead to the entire disintegration of the alloy, especially if iron, sodium, and silicon are present as impurities. Aluminum is likely to take up silicon from the crucible, especially if overheated. It is most important that these alloys should be melted without fluxes—such as mixtures of sodium and potassium chloride. Zinc chloride acts on the crucible, thereby causing the aluminum to wet its sides and to dissolve the silica, which in the presence of moisture forms silicon hydride, and this in time causes the entire disintegration of the alloy. Too much stress can not be laid on the fact that the metal must be melted at as low a temperature as possible. Aluminum absorbs sulphur at a bright-red heat, and the gas is liberated when the metal is poured into the molds, causing porous castings. Aluminum alloys

should therefore be melted in crucibles having good tight-fitting lids to prevent, to some extent, the absorption of sulphur from the fuel used. Numerous tests tend to indicate, according to Ivinson's experience, that silicon and sulphur are two of the deadly enemies of aluminum alloys, especially when the metal is overheated. Aluminum when heated to too high temperatures also absorbs nitrogen and hydrocarbons. A small piece of potassium nitrate (an egg spoonful to 100 pounds of metal) wrapped in filter paper has been found to be the best means of removing these occluded gases. After the reaction following the addition of the nitrate has ceased, the metal is poured at as low a temperature as possible, the pouring temperature affecting the tensile strength to a very marked degree. One of the best types of furnaces, found after a great many trials, for melting aluminum and its alloys is one which uses gas and air under pressure, the pressure used on the blower varying from 4 to 6 pounds to the square inch.

It is always advisable when making up an alloy of aluminum to make a concentrate of the metal which is to be alloyed with the aluminum—that is, to make first, say, a 20 or 25 per cent concentrate metal and add this in the proper proportions to the molten aluminum.

SOME RARE-METAL ALLOYS.

During the last few years metallurgists have been experimenting with some of the rare metals, and Ivinson has personally alloyed aluminum with almost all the rarer metallic elements, such as cerium, neodymium, lanthanum, tantalum, zirconium, and glucinum. Some of these alloys have shown most remarkable results, even those containing only 1 per cent or less of the rare metal. Cerium and glucinum are particularly interesting, 0.5 per cent of the former raising the tensile strength of the aluminum from 4.5 tons to 10.3 tons to the square inch and giving an elongation of 8.5 per cent on 2 inches. The alloy is prepared by reducing the fluoride of cerium. This alloy was placed in sea water and boiled for 60 hours. The sample was weighed before and after the boiling, and it was found that no weight was lost as a result of the experiment. One side of the metal was polished, and after the boiling it was found to be untarnished.

Another interesting alloy is one with glucinum. An alloy containing 2 per cent of glucinum showed a tensile strength of 11.8 tons to the square inch and an elongation of 10 per cent on 2 inches. It had a beautiful silver-white color and could be hammered cold into leaf; it also withstood perfectly the action of sea water. This alloy was made by the reduction of glucinum fluoride.

ALLOYS OF HIGH MELTING POINT.

Many experiments have been made during the last two or three years with alloys of aluminum and manganese, titanium, chromium, molybdenum, tungsten, etc. These metals with aluminum form a very interesting series of alloys, either by themselves or in the presence of copper. Titanium and chromium alloys are both affected by sea water and ordinary atmospheric conditions. If they are polished, the presence of sea water develops white spots on the surface which, when removed, show in their place deep pit marks. The behavior

of both alloys in resisting atmospheric conditions was far from satisfactory. Two methods have been employed to manufacture them—(1) the reduction of titanium and chromium oxide in a magnesite-lined crucible by means of powdered aluminum; (2) the reduction of the oxides of the metals by molten aluminum, cryolite and potassium chloride being used as fluxes. The cryolite is first melted in the crucible and in it is dissolved the oxide of the metal. Molten aluminum is then added, and a complete reduction of the titanium or chromium oxide takes place. These metals give very rigid and hard alloys. The tensile strength of one containing 2 per cent of metallic titanium was 10.4 tons to the square inch, and the elongation 4.5 per cent on 2 inches. The alloy containing 1.5 per cent of metallic chromium had a tensile strength of 9.34 tons to the square inch and an elongation of 2½ per cent on 2 inches.

Tungsten has been recommended as a suitable metal to alloy with aluminum to resist corrosion, but according to Ivinson's experience it has not proved very satisfactory. An alloy containing 2 per cent of copper and 0.5 per cent of tungsten rapidly disintegrated under ordinary atmospheric conditions. At least 100 different samples of this alloy were prepared in the varying proportions of 0.2 to 5 per cent pure tungsten alloyed with the aluminum either by itself or in conjunction with nickel, manganese, copper, etc. The results with some of these alloys were disappointing. An alloy containing 3 per cent of nickel and 0.75 per cent of zirconium showed the extraordinary tensile strength of 12.2 tons to the square inch and an elongation of 9 per cent on 2 inches. Its behavior in sea water was also very extraordinary; after being boiled for 72 hours in sea water it showed a tensile strength of only 4 tons to the square inch. Its fracture was very crystalline, and it was also very brittle.

Zirconium when alloyed with aluminum to the extent of 0.75 per cent without nickel gave the same tensile strength after boiling as before, namely, 9.3 tons to the square inch. Molybdenum when alloyed with aluminum showed the opposite result. An alloy containing 1.5 per cent of molybdenum, after being boiled in salt water, had a lower tensile strength than before; but when molybdenum was alloyed with aluminum in the presence of copper in the proportions of molybdenum 1.5 per cent and copper 1.5 per cent, the tensile strength of the alloy after boiling was the same as originally. The only drawback to the use of the rare metals in alloys is their prohibitive cost, but it is to be hoped that chemists and metallurgists will continue to experiment so as to produce these metals at a commercial price. No doubt much has been done in this direction since the advent of the Goldschmidt process for the reduction of the rarer metals from their oxides by means of powdered aluminum.

ALLOYS OF ALUMINUM AND COBALT.[1]

Researches into the chemical relation of aluminum and cobalt in the form of an alloy tend to show that the two metals are soluble in each other. Of the various alloys that have been made and studied, that with the least percentage of cobalt had one-third of this metal, whose solidifying point is somewhat above 100° C. The eutectic between cobalt and aluminum contains only 0.5 per cent of cobalt

[1] Grimshaw, R., The Metal Industry, January, 1913, p. 9.

and has a melting point lower than that of pure aluminum. There is also in the curve showing the melting points of the aluminum-cobalt alloys a decided change at the point corresponding to 20 per cent of cobalt.

Alloys with 9 to 12 per cent of cobalt are almost free from bubbles, although the fracture is somewhat coarse and crystalline. The tensile strength of such alloys is not much above that of pure aluminum, but they are more readily turned and polished and are much more resistant to atmospheric influences. These alloys are still fairly light and are much more workable than pure aluminum. Their lack of tensile strength is due to the coarse crystalline fracture, but this may be improved by the addition of tungsten or molybdenum, so that with the help of these metals an alloy containing but a small percentage of cobalt may have three times the tensile strength of aluminum and is also malleable and ductile. The alloys with tungsten run about 0.8 to 1.2 per cent of tungsten and 8 to 10 per cent of cobalt, aluminum making up the remainder. The more cobalt these alloys contain the less readily they can be rolled but the greater their tensile strength; so that those with a high percentage of cobalt are better for castings and those with a low percentage are better for forging and rolling. The alloys of molybdenum, cobalt, and aluminum contain from 0.6 to 1 per cent of molybdenum and 9 to 10 per cent of cobalt. They follow about the same general rules as those of tungsten, cobalt, and aluminum, except in the matter of hardness, in which they are inferior to the corresponding tungsten-cobalt alloys.

SILVER-ALUMINUM ALLOYS.

Certain silver-aluminum alloys invented and patented by William A. McAdams have been named argental, argalcum, agalcuzan, macadamum, altinum, and alancuzan. The claim is made that these are the only known alloys of the commercial metals which are nontarnishable in the air, are nonpoisonous, and will stand nitric acid. They are said to have great strength and wearing qualities. [1]

PRODUCTION OF ALUMINUM SALTS.

The following table gives the domestic production, the imports, and the value of aluminum salts from 1909 to 1913 inclusive.

Production and imports of aluminum salts into the United States, 1909–1913, in short ton

Years.	Production.						Imports.[a]	
	Alum.			Aluminum sulphate.			Quantity.	Value.
	Quantity.	Value.	Per ton.	Quantity.	Value.	Per ton.		
1909	9,237	$295,682	$32.01	115,366	$2,214,122	$19.19	1,459	$29,061
1910	9,090	300,763	33.09	126,792	2,447,552	19.30	2,127	53,671
1911	10,468	329,686	31.49	134,077	2,743,336	20.46	2,283	56,833
1912	9,246	293,995	31.80	150,427	2,909,495	19.34	3,342	84,606
1913	9,605	312,822	32.57	157,749	2,977,708	18.88	2,702	66,549

[a] Includes alumina, aluminum hydrade, or refined bauxite, alum, alum cake, aluminum sulphate, aluminous cake, and alum in crystals or ground.

[1] The Metal Industry, vol. 11, No. 8, p. 356, August, 1913.

BIBLIOGRAPHY.

The more important publications in English treating of bauxite, aluminum, and aluminum salts are listed below. This list includes also the principal latest papers devoted mainly to the technology of aluminum.

Ashley, G. H., Bauxite mining in Tennessee: Resources of Tennessee, vol. 1, No. 6, pp. 211–219, 1911.

Aubrey, A. J., The refractory uses of bauxite: Eng. and Min. Jour., Feb. 3, 1906, pp. 217–218.

Berger, W. F. B., Bauxite in Arkansas: Eng. and Min. Jour., Apr. 14, 1904, pp. 606–607.

Branner, J. C., The bauxite deposits of Arkansas: Jour. Geology, vol. 5, pp. 263–289, 1897.

Butler, B. S., and Gale, H. S., Alunite, a newly discovered deposit near Marysvale, Utah: U. S. Geol. Survey. Bull. 511, 64 pp., 1912.

Engineering and Mining Journal, Bauxite brick: Issue for Jan. 19, 1905, p. 154.

Hayes, C. W., Bauxite: U. S. Geol. Survey Mineral Resources for 1893, pp. 159–167, 1894.

——— The geological relations of the southern Appalachian bauxites deposits: Am. Inst. Min. Eng. Trans., vol. 24, pp. 243–254, 1895.

——— Bauxite, its occurrence, geology, origin, economic value: U. S. Geol. Survey Sixteenth Ann. Rept., pt. 3, pp. 547–597, 1895.

——— The Arkansas bauxite deposits: U. S. Geol. Survey Twenty-first Ann. Rept., pt. 3, pp. 435–472, 1901.

——— Bauxite in Rome quadrangle, Georgia-Alabama: U. S. Geol. Survey Geol. Atlas, Rome folio (No. 78), p. 6, 1902.

——— The Gila River alum deposits: U. S. Geol. Survey Bull. 315, pp. 215–223, 1907.

Holland, T. H., The occurrence of bauxite in India: Geol. Survey India Records, vol. 32, pt. 2, pp. 175–184, 1905.

Horton, J., The manufacture of aluminum: Toronto Eng. Soc. School of Prac. Sci. Trans., No. 18, pp. 113–123, 1905.

Hunt, A. E., Aluminum (and bauxite): U. S. Geol. Survey Mineral Resources for 1892, pp. 227–254, 1893.

——— Bauxite: Am. Inst. Min. Eng. Trans., vol. 24, pp. 855–861, 1895.

——— Aluminum, Aluminum Co. of America, Pittsburgh, Pa., 268 pp., 1904.

Institution of Mechanical Engineers, Minutes of meeting, alloys of aluminum and copper: Engineering, Mar. 8, 1907, pp. 299–307.

Judd, Edward K., Aluminum: Mineral industry during 1905, pp. 11–22.

——— The bauxite industry of the South: Eng. and Min. Jour., Mar. 23, 1907, pp. 574–575.

——— Bauxite: Mineral Industry, vol. 16, pp. 97–102, 1908.

McCalley, H., Bauxite: The valley regions of Alabama, pt. 2, Alabama Geol. Survey, pp. 79–84, 1897; also descriptions of Calhoun and Cherokee counties.

McCallie, S. W., Bauxite deposits of southern Georgia: Eng. and Min. Jour., May 27, 1911, p. 1050.

Minet, Adolphe, The production of aluminum and its industrial use, 1st ed., corrected (translated with additions by Leonard Waldo), 266 pp., 57 ills., John Wiley & Sons, New York, 1910.

Packard, R. L., Aluminum (and bauxite): U. S. Geol. Survey Mineral Resources for 1891, pp. 147–163, 1892.

——— Aluminum: U. S. Geol. Survey Sixteenth Ann. Rept., pt. 3, pp. 539–546, 1895.

Paint, Oil, and Drug Review, Aluminum paints: Issue for Aug. 15, 1906, p. 30.

Phalen, W. C., Bauxite and aluminum: U. S. Geol. Survey Mineral Resources for 1909, pt. 1, pp. 561–572, 1911.

——— Idem for 1910, pt. 1, pp. 711–723, 1911.

——— Idem for 1911, pt. 1, pp. 923–939, 1912.

——— Idem for 1912, pt. 1, pp. 949–962, 1913.

Phillips, W. B., and Hancock, David, The commercial analysis of bauxite: Am. Chem. Soc. Jour., vol. 20, pp. 209–225, 1898.

Richards, J. W., Alumnum, its history, occurrence, properties, metallurgy, and applications, including its alloys, 3d ed., Baird & Co., Philadelphia, 1896.

Schnatterbeck, C. C., Aluminum and bauxite: U. S. Geol. Survey Mineral Resources for 1904, pp. 285–294, 1905.

Spencer, J. W., Bauxite (the Paleozoic group): Georgia Geol. Survey, 1893, pp. 214–239.

SPURR, J. E., Alum deposits near Silver Peak, Esmeralda County, Nev.: U. S. Geol. Survey Bull. 225, pp. 501–502, 1904.
STACY-JONES, J. E., Light aluminum alloys: Indust. World, May 11, 1907, pp. 593–596.
STRUTHERS, JOSEPH, Aluminum and bauxite: U. S. Geol. Survey Mineral Resources for 1903, pp. 265–279, 1904.
SUTHERLAND, JAMES, The preparation of aluminum from bauxite: Eng. and Min. Jour., Oct. 3, 1896, pp. 320–322.
VEATCH, OTTO, Report on the bauxite deposits, Wilkinson County, Ga.: Georgia Geol. Survey Bull. 18, Appendix D, pp. 430–447, 1909.
WATSON, T. L., The Georgia bauxite deposits, their chemical constituents and genesis: Am. Geologist, vol. 28, pp. 25–45, 1901.
——— Bauxite deposits of Georgia: Georgia Geol. Survey Bull. 11, 1904.
WETHERELL, E. W., Laterite in Mysore: Mysore Geol. Dept. Memoirs, vol. 3, pt. 1, p. 27.

CHROMIC IRON ORE.

By J. S. Diller.

INTRODUCTION.

A notable feature of the chromic iron ore industry in 1913 was the increased production and sale compared with that of 1912. The total output of chromic iron ore in this country comes from one producer in California. In 1912 the total production was 201 long tons,[1] valued at $2,753. In 1913 the production was 255 long tons, valued at $2,854, a gain of 27 per cent in quantity but of less than 4 per cent in value. The ore is reported to contain 47 per cent chromic oxide.

The two new mines reported last year, one near Livermore, in Alameda County, and the other near Piedra, in Fresno County, were not operated in 1913. The production of 1913 came wholly from L. H. Brown's mine on the south side of Little Castle Creek, in Shasta County, about 2½ miles south of Dunsmuir. This mine is near the Siskiyou County line, and Mr. Brown's claims extend into Siskiyou County, but the open cut from which the ore is now obtained is well within Shasta County, although ore taken from the same place last year was reported as mined in Siskiyou County because the place is near the post office of Dunsmuir.

The largest production of chromic iron ore ever recorded in the United States was in 1894, when the output reached 3,680 long tons, valued at $53,231; the highest value was attained in 1883, when an output of 3,000 tons had a value of $60,000. The following table shows the quantity, value, and price per ton of chromic iron ore produced in the United States since 1880. All the ore came from California except a little that was mined in Wyoming in 1908 and 1909.

Production of chromic iron ore in the United States, 1880–1913, in long tons.

Year.	Quantity.	Value.	Price per ton.	Year.	Quantity.	Value.	Price per ton.
1880	2,288	$27,808	$12.15	1897			
1881	2,000	30,000	15.00	1898			
1882	2,500	50,000	20.00	1899			
1883	3,000	60,000	20.00	1900	140	$1,400	$10.00
1884	2,000	35,000	17.50	1901	368	5,790	15.73
1885	2,700	40,000	14.81	1902	315	4,567	14.50
1886	2,000	30,000	15.00	1903	150	2,250	15.00
1887	3,000	40,000	13.33	1904	123	1,845	15.00
1888	1,500	20,000	13.33	1905	22	375	17.05
1889	2,000	30,000	15.00	1906	107	1,800	16.82
1890	3,599	53,985	15.00	1907	290	5,640	19.45
1891	1,372	20,580	15.00	1908	359	7,230	20.14
1892	1,500	25,000	16.67	1909	598	8,300	13.88
1893	1,450	21,750	15.00	1910	205	2,729	13.31
1894	3,680	53,231	14.46	1911	120	1,629	13.58
1895	1,740	16,795	9.65	1912	201	2,753	13.70
1896	786	6,667	8.48	1913	255	2,854	11.19

[1] In view of the fact that the California State Mining Bureau, as stated in the newspapers and in Mineral Industry for 1912, reported a production of 1,220 tons in Shasta and Siskiyou counties, whereas the United States Geological Survey reported only 201 long tons, the subject was reviewed in the field in 1913, but no evidence was found to warrant a change in the Survey's figures.

WORLD'S PRODUCTION.

The insignificance of the production of chromic iron ore in the United States will be more fully appreciated by comparison with that of some of the foreign countries, especially New Caledonia, Rhodesia, and Turkey, as shown in the following table:

World's production of chromic iron ore, 1907–1912, in long tons.

Country.	[a] 1907	[a] 1908	[a] 1909	[a] 1910	[a] 1911	[b] 1912
United States	290	359	598	205	120	201
Bosnia and Herzegovina	305	492	327	315	246	197
Canada	6,425	6,451	2,205	267	[c] 157	.....
Greece	11,545	4,281	9,448	9,311	4,542	[d]
India	7,274	4,745	9,250	1,737	3,804	2,890
Japan	[d]	[d]	[d]	2,091	1,500	[d]
New Caledonia	3,739	15,550	39,368	39,368	34,447	[e] 50,505
New South Wales	30	.....	.....	.....	.....	23
Rhodesia	8,017	11,927	22,875	39,287	46,753	61,857
Russia	25,940	10,777	21,857	[d]	[d]	[f] 20,934
Sweden	.....	.....	.....	31	.....	[d]
Turkey	[c] 21,111	28,394	11,364	[d]	[d]	[d]

[a] Statistics taken from Mines and Quarries: General report with statistics, pt. 4, London.
[b] Statistics, except for the United States, taken from various sources, including Mineral Industry, 1912.
[c] Mineral production of Canada for 1912, Ottawa 1913.
[d] Statistics not available.
[e] Export figures.
[f] Mining Journal, Aug. 9, 1913, p. 754.

PRICES.

There is no import duty on chromic iron ore, and its occurrence near the sea in foreign countries enables it to be imported and sold along our eastern coast at low rates. Chromite is usually sold on the basis of 50 per cent content of chromic oxide. It was quoted [1] for carload lots ex ship in New York during 1912 at $14 to $16 a ton, although the price of imported chromite for the year averaged only $9.27 a long ton. The average value of the chromite imported during the fiscal year ending June 30, 1913, was $10.12, apparently an increase of 10 per cent over that of 1912 in the average price of the material imported. Nevertheless the market price quoted for imported chromite in lump form in carload lots at the Atlantic seaboard was $14 a net ton.

The price of ore on the Pacific coast has apparently been declining since 1901, but the difference may be due to the grade of the ore. In 1911 it was $13.58 a long ton and in 1912 the average was $13.70, although some of the richer ore sold for $17. In 1913 the average price of the ore sold declined to $11.19. On account of the long railroad haul the California chromic iron ore can not compete in the Atlantic States with the cheaply delivered foreign ore.

The price of the chromate and bichromate of potash imported in 1912 averaged 9 cents a pound and that of the chromic acid 15¾ cents a pound. In January, 1914, American manufacturers quoted bichromate of potash at 6¾ to 7¾ cents a pound and bichromate of soda at 4¾ to 5 cents a pound f. o. b. at the seller's works.

The market price of chrome brick, standard sizes, in carload lots, January 1, 1914, was, at the Atlantic seaboard, $135 a thousand; at Pittsburgh, $145 a thousand.

[1] Eng. and Min. Jour.

IMPORTS.[a]

For the calendar year 1913 only the total quantities and values of imports for consumption are available, but greater details of imports are available for the fiscal year ending June 30, 1913. The imports for the calendar year will be given first, to be followed by the detail of imports for the fiscal year.

Chromic iron ore, chromic acid, and chromates of potash imported and entered for consumption in the United States in calendar years 1908 to 1913, inclusive.

Year.	Chromic iron ore.		Chromic acid.		Chromate and bichromate of potash.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Long tons.		*Pounds.*		*Pounds.*		
1908	27,876	$345,960	3,805	$708	216,081	$15,453	$362,121
1909	39,624	460,758	7,559	1,412	537,017	28,837	491,007
1910	38,579	415,768	9,850	1,635	406,790	19,569	436,972
1911	37,540	407,958	6,789	1,349	22,408	2,159	411,466
1912	53,929	499,818	8,728	1,376	32,913	3,085	504,279
1913	65,180	622,821	5,562	1,100	18,629	1,819	625,740

In 1913 the imports of chromic iron ore amounted to 65,180 long tons, valued at $622,821, an increase of 11,251 tons in quantity and of $123,003 in value, as compared with the imports of 1912. Although the imports of chromates and chromic acid increased in 1912, they decreased in 1913.

Imports of chrome or chromium and ferrochrome in calendar years 1911, 1912, and 1913, in long tons.

	1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Valued at $200 and less per ton	240.03	$20,173	436	$47,179	307	$51,415
Valued at more than $200 per ton	13.50	7,729	38	30,408		

In the fiscal year ending June 30, 1913, the United States imported chromic iron ore from 5 countries, as against 10 countries reported in 1912. The following table shows the quantity and value from each country in 1912 and 1913:

Imports of chromic iron ore, by countries, fiscal years ending June 30, 1912 and 1913, in long tons.[a]

Country.	1912		1913		
	Quantity.	Value.	Quantity.	Value.	Value per ton.
British India	1,000	$6,600			
Canada	13	258			
England	54	676			
Greece	7,540	70,595			
Japan	190	1,381	322	$2,712	$8.42
Netherlands	25	387			
New Caledonia	6,600	41,399	6,620	47,913	7.24
Portugal	15,455	188,577	5,000	60,831	12.17
Portuguese Africa	5,100	62,048	24,000	291,981	12.17
Turkey in Asia	11,030	71,214	13,830	100,227	7.25
Total	47,007	443,135	49,772	503,664	10.12

[a] Commerce and Navigation: Dept. Commerce, 1913.

Portugal is not a producing country, but only a point of reshipment, mainly if not wholly for chromic iron ore from Rhodesia, via Beira, in Portuguese Africa. A preceding table shows clearly the source of the chromic iron ore used in the United States, and the following table shows the ports of entry from which the American industries are supplied. In 1912 Philadelphia was by far the most important port of entry for chromic iron ore on the Atlantic coast, but in 1913 more than half the imported ore entered at Baltimore. A small quantity in 1912 came in by way of New Orleans on the Gulf of Mexico, but none at all by way of the Pacific coast.

Ports of entry of imports of chromic iron ore in fiscal year ending June 30, 1913, in long tons.

Port.	Quantity.	Value.	Value per ton.
Baltimore	28,650	$299,930	$10.47
New York	5,322	63,543	11.94
Philadelphia	15,800	140,191	8.87
Total	49,772	503,664	10.12

Imports of chromium compounds for fiscal year ending June 30, 1913.[a]

	Quantity.	Value.	Value per unit.
Chromic iron ore, long tons	49,772	$503,664	$10.12
Chromic acid, pounds	8,522	1,682	.197
Chromate and bichromate of potash, pounds	27,671	2,601	.094
Chromate and bichromate of soda, pounds	9	3	.333
Chrome and ferrochrome, $200 or less per ton, long tons	459.09	53,624	116.80
Chrome and ferrochrome, more than $200 per ton, long tons	63.29	35,667	563.55

[a] Summary of imports for consumption for fiscal year ending June 30, 1913, Tables 15 and 16: Department of Commerce, 1913.

ORES OF CHROMIUM.

The most important minerals containing chromium are those of the spinel group, chromite and picotite. Practically the only commercial ore of chromium is chromite, of which the theoretical composition is expressed by the formula $FeO.Cr_2O_3$ in the proportion of 32 per cent ferrous oxide (FeO) and 68 per cent chromic oxide (Cr_2O_3). In many ores the ferrous oxide of the chromite is partly replaced by magnesia (MgO) and the chromic oxide by alumina (Al_2O_3) or ferric oxide (Fe_2O_3), so that the general formula becomes $(Fe,Mg)O.(Cr,Al,Fe)_2O_3$. The proportion of chromic oxide may then be as low as 10 per cent, but generally ranges between 40 and 60 per cent. The ore is usually marketed on the basis of 50 per cent chromic oxide.

The varieties containing but little chromium—10 per cent or less, according to Dana—are hardly more than varieties of spinel and may be classed under picotite.

Chromite is an almost constant accessory mineral of peridotite or pyroxenite or of serpentine derived from those rocks, and in many places forms irregular bunches or masses sufficiently large to mine.

It is one of the earliest minerals to separate and solidify in the original rock magma.[1] Some of the masses are unusually large. One in the Daghardy mine, near Brusa, Turkey, is reported as 70 meters long, 25 meters wide, and 20 meters deep, and the ore was valued at $25 a ton. When the country rock of such deposits is altered to serpentine, secondary deposits of chromite may be formed.

Although the great majority of chromic iron deposits originate in basic intrusive rocks like peridotite, there are others of low grade, like those of Greece [2] and the island of Skyros, that are reported to occur in association with limestone. Such deposits, although largely secondary, are apparently different from the most common type.

The properties of chromium which render it most useful in chemistry and metallurgy are the strong colors of its compounds, its high resistance to heat, its chemical neutrality, and its capacity to form alloys. Most of the chromium used in the United States is used for chemical purposes, but the metallurgic demands are increasing rapidly. Various pigments, dyes, and other chemical compounds are made of chromium, and it is used also in the tanning of leather, which it renders tough and resistant to moisture.

Chromite is one of the most difficultly fusible minerals, and for this reason it is used for furnace lining and in the manufacture of chrome brick. According to Brun,[3] chromite fuses at 1,850° C., although a sample recently tested by C. W. Kanolt [4] melted at 2,180° C. Chromium gives to steel a marked degree of hardness, and either alone or alloyed with tungsten, molybdenum,[5] nickel, vanadium, or manganese, it is used in making the metal for high-speed tools, armor plates, and projectiles for large guns. The uses of chromium were more fully considered in the reports for 1908 and 1912.

CHROMIC IRON ORE IN THE UNITED STATES.

Occurrence.—The chromium industry of the United States originated in Maryland, and the chromic iron ore was mined for more than 50 years prior to 1881 in Maryland [6] and the adjacent portion of Pennsylvania.[7] Chromite occurs in notable quantities also in a number of other States, especially North Carolina,[8] where it has been studied by Pratt and Lewis. It has been noted in the eastern border of the Rocky Mountains in Converse County, Wyo., but the only deposits operated in the United States within recent years are in California.[9] Numerous deposits have been reported in 32 counties of that State, and many of them could be worked if the demand for the ore and its value warranted exploitation. The available deposits, with much in reserve, largely exceed the local demand for refractory material in a field extending as far east as the Rocky Mountains.

California deposits.—Attention has recently been called to a deposit of chromic iron ore in Glenn County, Cal., from which several carloads were shipped about 20 years ago by boat to Philadelphia.

[1] Lindgren, Waldemar, Mineral deposits, p. 747, 1913.
[2] Iron Trade Review, Oct. 9, 1913, p. 624.
[3] Econ. Geology, January, 1912, p. 5.
[4] Eighth Internat. Cong. Applied Chemistry, vol. 22, p. 181, September, 1912.
[5] Haynes, E., Jour. Ind. Eng. Chemistry, March, 1913, p. 189.
[6] Maryland Geol. and Econ. Survey, Mineral industries, 1897–1907, p. 155.
[7] Top. and Geol. Survey Comm. Pennsylvania Rept. No. 4, p. 91, 1911.
[8] North Carolina Geol. Survey, vol. 1, p. 369, 1905.
[9] U. S. Geol. Survey Mineral Resources for 1908, pt. 1, p. 751, 1909.

The Mutual Chemical Co. of America made the following analysis of the ore for the owner, W. R. Chesley:

Analysis of chromic iron ore from Glenn County, Cal.

Cr_2O_3	51.61
FeO	18.09
Fe_2O_3	.50
Al_2O_3	14.62
SiO_2	1.40
MgO	13.06
CaO	.24
Loss on ignition	.40
	99.92

This deposit of high-grade ore occurs as several bodies of considerable size in serpentine form at a point 24 miles west of Willows and

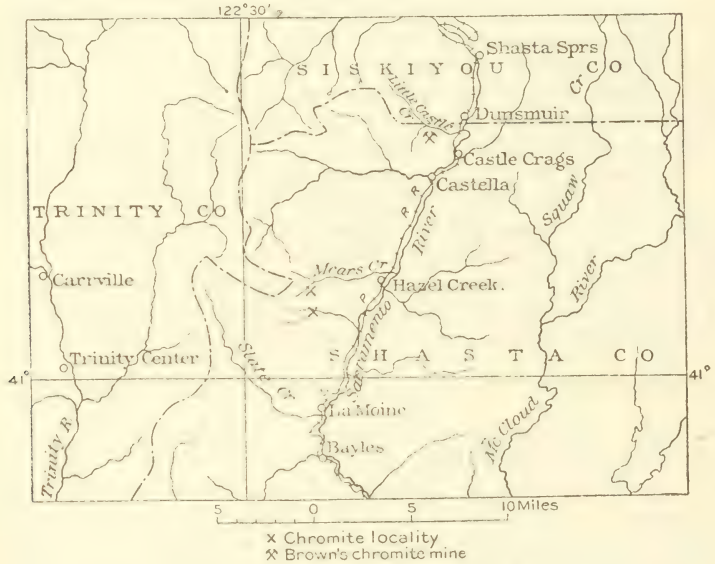

FIGURE 2.—Map showing chromic iron ore localities in Shasta County, Cal.

15 miles from Fruto, the nearest railroad station, with which it is connected by wagon road.

The bodies of chromic iron ore near Livermore, in Alameda County, and those 14 miles east of Fresno, in Fresno County, controlled by the Levensaler-Speir Corporation, of San Francisco, have not been operated in 1913 except to furnish about 2 carloads of sample material. A new road is being constructed within 2 or 3 miles of the Fresno County deposit.

The most important deposit of chromic iron ore at present is in the northern border of Shasta County near Dunsmuir. Figure 2 shows the location of the open cut from which, at an elevation of about 3,000 feet, the ore is conveyed by a 2-bucket gravity tramway 1,600 feet in length, dropping 700 feet to a wagon road on Little Castle Creek less than a mile from the Southern Pacific Co.'s main line. The situation of the mine on a steep slope near the railroad affords great advantages in cheap operation and transportation. This enables the

operator readily to adjust production to demand, thus avoiding storage and reducing the cost of production.

The country rock is in part serpentine derived from the alteration of pyroxenite and peridotite, but in the main the alteration to serpentine is not far advanced. The ore body is apparently lenticular, having a width as worked in the open cut of 25 feet and a length of more than 100 feet in the direction N. 54° E. The ore body is bounded on the southeast by a fault fissure parallel to the deposit and dipping 74° SE. to 90°. On the northwest the limit of the ore body is generally vertical. Another fault fissure with a little gouge runs through the ore body, lengthening near the middle. The ore northwest of this fault fissure is less rich than that southeast of it. The richer ore consists of black granular chromite with more or less chlorite, some of which is green and some pink like chromic chlorite, or rhodophyllite. The richest ore of chromite contains considerable chromic-chlorite. The average run of the ore as marketed is said to contain 45 per cent chromic oxide.

The richest portions of the ore body consist wholly of chromite in irregular nodules, generally less than a foot in diameter and not abundant. On carefully examining a nodule of such ore, especially toward the margin, with a hand lens, pink grains of chromic chlorite will be found to occur in fractures of the chromite and to increase in quantity toward the indefinite boundary of the chromite nodules, where the chlorite fills the fractures and forms a network inclosing the grains of chromite. Mixed with the chromic chlorite is more or less greenish chlorite and serpentine, all of which are secondary minerals derived from the alteration of enstatite and olivine, the two essential mineral constituents of the country rock. In the lower-grade portions of the ore body there are many places where the enstatite inclosing the more or less prominent grains of chlorite is fresh, with but little trace of alteration.

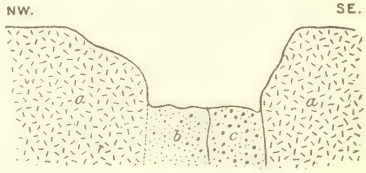

FIGURE 3.—Section of Brown's chromic iron ore mine, Shasta County, Cal. *a*, Pyroxenite, in some places saxonite or dunite; *b*, lean ore—granular groups of chromite in pyroxene and olivine; *c*, ore richer in chromite, pyroxene, and olivine (?) altered to chlorite and chromic chlorite.

In figure 3 the general relations of the ore body to the country rock are illustrated. The fault zone, about a foot in width on the southeast side of the ore, is occupied mainly by chloritic material with a sharp boundary toward the ore, but on the opposite side the limit is not well marked and the ore appears to grade into the country rock. On the face of the open cut a mass of serpentine appears, possibly as a horse in the ore body, and its boundary is sharp.

The country rock in the vicinity of the ore body is in general composed almost wholly of pyroxene. In places the rock contains some olivine, and locally the olivine becomes so abundant as to make up the whole mass. The same rock mass appears to present a complete gradation from pyroxenite to peridotite. Both kinds of rock occur in connection with the bodies of chromic iron ore and are equally involved in the genesis of the ore. A rather striking feature of the country rock is its richness in magnetite and lack of chromite, in contrast with the body of chromic iron ore, which contains very little if any magnetite. There is considerable asbestos of the slip-

fiber type near the boundary of the bodies of chromic iron ore and the black ore associated with it is magnetite instead of chromite.

The Little Castle Creek body of chromite is not near the boundary of the mass of serpentine in which it occurs. The serpentine extends southwest and south along the divide west of Sacramento River to Shotgun Creek, where chromite was mined a number of years ago. The relations of the two localities to drainage and transportation are shown in figure 2. At the forks of Shotgun Creek about a mile from the Southern Pacific line a series of lenticular chromite bodies occur in a somewhat indefinite shear zone which is vertical and trends S. 40° W. through the serpentine. Five bodies containing from 200 to 1,500 tons each connected by more or less distinct veinlike leaders have been mined to a depth of not more than 40 feet within a distance of 250 yards. Except for these leaders the ore masses have nothing in them resembling vein structure. Generally the ore separates easily from the serpentine, but some of it adheres firmly. Other parallel but less productive zones have been found in the same region. A partial analysis of an average sample of the ore selected at the mine gave Cr_2O_3, 48.87 per cent; FeO, 15.86 per cent. All the iron was reckoned as FeO. No platinum, gold, or silver was present. At this locality 315 tons of chromic iron ore was mined in 1903. The mine was operated for several years, the output being used as a refractory material. It has not been worked recently and is now in the hands of the Noble Electric Steel Co., which has an electric smelter at Heroult, on Pit River, The deposit may present interesting possibilities in the manufacture of ferrochrome.

Several bodies of chromic iron ore have been reported between Shotgun Creek and Little Castle Creek, but none have been exploited.

Some bowlders of chromite containing 50 per cent of chromic oxide have been reported in Tulare County.

FOREIGN SOURCES OF CHROMITE.

Rhodesia.—Rhodesia, in British South Africa, produces and markets more chromic iron ore than any other country and delivers it a few hundred miles by railroad across Portuguese East Africa to Beira for ocean shipment. In 1912 the reported shipment from Beira was 61,548 tons, and more than half of it came to the United States. The total chromic iron ore produced in Rhodesia up to and including 1912 was 216,268 tons, valued at £497,948. For the seven months, January, March, April, May, July, October, and November, 1913, reported by the Mining Journal of London, Rhodesia produced 37,995 tons, so it is evident that the country has kept up its large production of 1912. The principal point of production is at Selukwe, but deposits of chromic iron ore occur in other parts of Rhodesia, as at Victoria, Makwiro, and Lomagundi. The content of chromic oxide in the ore varies from place to place. At Makwiro it is low and at Selukwe high. The deposits appear to be connected with a great intrusion of picrite which runs north and south through southern Rhodesia from Zambesi River almost to the Limpopo and at several places is altered along the margin to serpentine.

Deposits of chromic iron ore are reported also in Transvaal and Natal.

Turkey in Asia.—Several large mines of chromic iron ore have been operated in the vicinity of Messina, on the coast of Turkey in Asia

about 100 miles northeast of Cyprus. The ore is said[1] to contain 51 to 53 per cent of chromic oxide and is exported in large quantities to France and Germany. Large bodies of chromic iron ore have been reported at other points in Asiatic Turkey, particularly in the neighborhood of Brusa. In 1912 a total of 11,030 long tons of chromic iron ore, valued at $6.45 a ton, was imported into the United States from Turkey in Asia.

Greece.—The chromic iron ore of Greece, which is third in the order of quantity sent to the United States, occurs mainly in the eastern provinces and in the island of Skyros. As a refractory material Grecian chromic iron ore excels, largely on account of the impurities it contains. The higher grades of chromic iron ore are mined in Larissa, the eastern portion of Thessaly. Imported Grecian chromic iron ore contains approximately 3 to 5 per cent of silica and 38 to 42 per cent of chromic oxide. The low grades, some of which are known as "chromiferous iron ore,"[2] occur farther south, in the country between Lake Copias and the channel of Talanta, which affords convenient marine transportation. The chromiferous iron ores are remarkable for their rather uniformly complex composition, containing besides a large amount of iron and some alumina a smaller proportion of chromium, silica, nickel, cobalt, phosphorus, sulphur, and titanium. The composition of the dry ore of the different deposits varies within the following limits:

Range of composition of Grecian chromiferous iron ore.

	Per cent.
Iron	45.00–52.00
Alumina	6.00–14.00
Silica	5.00–11.00
Chromium	2.00– 3.00
Nickel and cobalt	.10– 1.20
Phosphorus	Trace– .03
Sulphur	.02– .05
Titanium	Trace– .30

The low-grade deposits are said to occur in limestone and appear to be largely of secondary origin, in contrast to the richer ores of chromite in intrusive rocks, which are primary.

The ore is so easily mined and conveniently transported that the total cost, including royalty to the State and placing the mineral f. o. b. loading port, is only about $1.22 a ton. The selling price is $1.28 a ton, with 20 cents for loading.

New Caledonia.—In 1912 New Caledonia exported[3] 51,316 metric tons (50,505 long tons) of chromic iron ore, a gain of 16,058 long tons compared with the exports of 1911. The largest exports went to Germany and the United States. The value per ton of the ore shipped in 1911 and 1912 was £1 8s. 5d. ($6.81).

The Chrome Co., which controls the deposits of New Caledonia, intends to construct hydroelectric works of 15,000 horsepower for the purpose of manufacturing ferrochrome and ferronickel.[4] The primitive methods of mining have been superseded by modern practice, which has already given favorable results. The facilities for handling the ore from the mine to the shipping port and for loading

[1] Daily Cons. Trade Repts., Dec. 31, 1913, p. 1516.
[2] Iron Trade and Review, Oct. 9, 1913, p. 624.
[3] Eng. and Min. Jour., vol. 95, p. 782, Apr. 12, 1913
[4] Idem, vol. 95, p. 1288, June 28, 1913.

the steamers at the ports are of the most modern kind. A good deal of the ore from New Caledonia is now being loaded on ship at Pagoumene, although much of it is still loaded at Noumea.

India.—The most important chromium mine in southern India is at Tipatur, about 90 miles northwest of Bangalore, and at the present time its production is about 2,600 tons annually. Nearly half of the output is imported by the United States.[1] The tanning of chrome leather with American machinery has become a thriving industry in southern India.

Large quantities of high-grade ore have been reported[2] in the Zhob district of Baluchistan, but owing to the high cost of transportation and the low price in European markets the profits are small. The production in 1911 was 3,804 tons.

Other countries.—Canada in 1911 produced 157 tons of chromic iron ore valued at $2,587,[3] and 13 tons were imported into the United States by way of Niagara Falls. In 1912 and 1913 no production was reported.

Japan produced a small amount of chromic iron ore in 1912 and sent 190 tons, valued at $1,581, to the United States.

Russia is reported in the St. Petersburg papers[4] to have produced in 1912 from the mines of the Ural Mountains 1,300,024 poods, or 20,934 long tons of chromic iron ore.

RECENT PUBLICATIONS CONCERNING CHROMIUM.

Recent investigations concerning chromium and its combinations have been directed chiefly to its metallurgy, especially that of its alloys, and its application has been greatly widened. In search of an alloy that would withstand the solvent action of strong acids, S. W. Parr[5] reports the following composition of an alloy which may be cast, drawn into wire, and spun readily, so that it may have many interesting applications:

Composition of acid-resistant alloy of chromium.

Ni	66.6
Cr	18.0
Cu	8.5
W	3.3
Al	2.0
Mn	1.0
Zi	.2
B	.2
Si	.2
	100.0

Hard, tough, and elastic alloys of cobalt, chromium, and one or more other metals capable of taking a high polish and receiving and retaining a sharp cutting edge so as to be suitable for making cutting tools have been described by E. Haynes[6] and patents have been issued concerning them.

[1] Daily Cons. Trade Repts., Sept. 2, 1913, p. 1261.
[2] Idem, Jan. 30, 1914, p. 292.
[3] Mineral production of Canada during the calendar year 1912, p. 6.
[4] Min. Jour., Aug. 9, 1913, p. 754.
[5] Internat. Cong. Ind. Chemistry, vol. 2, p. 209.
[6] Met. and Chem. Eng., May, 1913, p. 293. Patent 1057423-828, Apr. 1, 1913.

Robert M. Keeney,[1] of the Bureau of Mines, describes in detail the electric smelting of chromium, tungsten, molybdenum, and vanadium ores, the reduction of chromite, and the electric furnaces used in manufacturing ferrochrome. He calls attention to some experiments made by him in 1912 on the production of ferrochrome from chromite with carbon as a reducing agent. Among the conclusions he draws one is that "ferrochrome can be easily manufactured directly from chromite in the electric furnace."

A patent was granted [2] in 1911 to E. F. Price, of Niagara Falls, for the electric production of ferrochromium from chromite.

The use of carbides of chromium and titanium in arc-light electrodes has been patented [3] by E. R. Berry.

In testing the thermal resistivity of ceramics, C. P. Randolph [4] obtained the following results concerning chromium:

Thermal resistivity of chromium.

Material.	Temperature of firing (°C.).	Density (pounds per cubic foot).	Temperature (°C.).	Resistivity (degrees per watt per cubic inch).
Chromite brick	1,300	128	1,200	38
				17
				14
Chromite and clay brick	1,050	144	1,000	34

The chromite and clay brick contained chromic iron ore with a large amount of clay binder, making practically a clay brick.

In studying the melting points of fire bricks C. W. Kanolt [5] tested one brand of brick made from chromite and found it to melt at 2,050° C. A sample of natural chromite from a different source melted at 2,180° C. According to Brun the melting point of chromite is 1,850° C.[6]

[1] Met. and Chem. Eng., Oct., 1913, p. 585. See also p. 579.
[2] Chem. Abstracts, vol. 5, p. 2617, 1911. Patent 995481, June 20, 1911.
[3] Patent 1017497, Feb. 13, 1912.
[4] Gen. Elec. Review, Feb., 1913, p. 125.
[5] Eighth Internat. Cong. App. Chemistry, vol. 22, pp. 171, 181.
[6] Lindgren, Waldemar, Mineral deposits, p. 747, 1913.

GOLD, SILVER, COPPER, AND LEAD IN SOUTH DAKOTA AND WYOMING.

SOUTH DAKOTA.

By Charles W. Henderson.

PRODUCTION.

The total value of the production of gold, silver, copper, and lead in South Dakota in 1913, as reported from 30 productive mines, of which 10 were placers, amounted to $7,424,333. This is $595,038 less than the output for 1912, which is the largest production made in any one year. The gold output in 1913 was 354,070.85 fine ounces, valued at $7,319,294, nearly 99 per cent of the total value. The decrease in gold yield for the year was 27,674.17 fine ounces in quantity and $572,076 in value. The production of silver also decreased from 206,460 to 172,702 fine ounces. Smelting ore from South Dakota carried 1,793 pounds of copper, against none in 1912, and 10,205 pounds of lead, against 22,845 pounds in 1912. Some of the placer gold was sold for use in the arts.

The total quantity of ore mined and treated in 1913 was 1,899,167 short tons, averaging 0.186 ounce, or $3.85 in gold per ton as compared with 1,901,726 short tons, averaging 0.20 ounce, or $4.14 in gold in 1912, with 1,946,127 short tons, averaging $3.187, in 1911, and with 1,523,929 short tons, averaging $3.543, in 1910. There were 1,895,445 tons treated in the mills of the State, yielding as bullion $7,219,399 in gold, and 163,359 fine ounces of silver, valued at $98,669, a total value of $7,318,068, or an average recovery per ton of $3.81 in gold and of $0.52 in silver, as compared with $4.08 in gold and $0.058 in silver in 1912, and with $3.77 in gold and $0.05 in silver in 1911. The quantity of crude ore shipped to smelters amounted to 3,722 tons, having an average content in gold of 1.28 fine ounces, or $26.465 per ton, and of 2.508 ounces in silver.

Tonnage of ore to gold and silver mills, with quantity of gold and silver contained in bullion produced in South Dakota in 1913, by processes.

Ore to gold and silver mills.		Process.	Gold in bullion.	Silver in bullion.
			Fine ozs.	*Fine ozs.*
1,540,961	short tons..	Amalgamation....	224,648.96	65,686
1,855,000 [a]	do....	Cyanidation.....	124,589.46	97,673
Total.....		.....	349,238.42	163,359

[a] Contains 1,500,516 tons tailings from part of tonnage amalgamated.

The consumption of quicksilver and cyanide in South Dakota mills in 1913 was 12,150 pounds of quicksilver,[1] 113,727 pounds of potassium cyanide,[2] and 388,961 pounds of sodium cyanide.[2]

[1] Represents 1 pound of mercury per 18.49 ounces of gold; or 1 ounce of mercury per 1.55 ounces of gold and 1 pound of mercury per 127 tons of ore.

[2] Potassium and sodium cyanide combined were used at a ratio of 0.37 pound of cyanide per ton of ore or tailings treated, and for every pound used there was recovered 0.248 ounce of gold.

Mine production of gold, silver, copper, and lead in South Dakota in 1912 and 1913.

Year.	Number of mines producing.	Tonnage.	Gold.[a]		Silver.[a]		Copper.		Lead.		Total value.
			Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
		Short tons.	*Fine ounces.*		*Fine ozs.*		*Pounds.*		*Pounds.*		
1912	40	1,901,726	381,745.02	$7,891,370	206,460	$126,973	.....	.....	22,845	$1,028	$8,019,371
1913	30	1,899,167	354,070.85	7,319,294	172,702	104,312	1,793	$278	10,205	449	7,424,333
Increase (+) or decrease (−)	−10	−2,559	−27,674.17	−572,076	−33,758	−22,661	+1,793	+278	−12,640	−579	−595,038

[a] Includes placer production.

Production of gold and silver in South Dakota from 1876 to 1913, inclusive.

Year.	Gold.	Silver.		Total commercial value.
	Value.	Fine ounces.	Commercial value.	
1876	[a]$1,200,000	3,867	$4,486	$1,204,486
1877	[a] 2,000,000	6,187	7,424	2,007,424
1878	[a]2,250,000	7,734	8,894	2,258,894
1879	[a]2,500,000	7,734	8,662	2,508,662
1880	[b] 3,305,843	[d] 54,770	[g] 62,986	3,368,829
1881	[b] 4,000,000	54,141	61,179	4,061,179
1882	[b] 3,300,000	135,352	154,301	3,454,301
1883	[b] 3,200,000	116,016	128,778	3,328,778
1884	[b] 3,300,000	116,016	128,778	3,428,778
1885	[b] 3,200,000	77,344	82,758	3,282,758
1886	[b] 2,700,000	328,711	[h]325,424	3,025,424
1887	[b] 2,400,000	417,656	[h] 409,303	2,809,303
1888	[b] 2,600,000	[d] 77,344	72,703	2,672,703
1889	[b] 2,900,000	[d] 50,000	47,000	2,947,000
1890	[b]3,200,000	[d] 100,000	105,000	3,305,000
1891	[b] 3,550,000	[d] 100,000	99,000	3,649,000
1892	[b] 3,700,000	[d] 60,000	52,200	3,752,200
1893	[d] 4,006,400	[d] 140,400	109,512	4,115,912
1894	[d] 3,868,155	[d] 58,973	37,153	3,905,308
1895	[d] 3,869,500	[d] 159,300	103,545	3,973,045
1896	[d] 4,969,800	[d] 229,500	156,060	5,125,860
1897	[d] 5,694,900	[d] 147,600	88,560	5,783,460
1898	[d] 5,699,700	[d] 152,300	89,857	5,789,557
1899	[d] 6,469,500	[d] 145,600	87,360	6,556,860
1900	[d] 6,177,600	[d] 535,200	[d i] 332,444	6,510,044
1901	[d] 6,479,500	[d] 78,000	[d] 46,800	6,526,300
1902	[d] 6,965,400	[d] 340,200	[d] 180,306	7,145,706
1903	[d] 6,826,700	[d] 221,200	[d] 119,448	6,946,148
1904	[e] 7,363,977	[e] 161,611	[j] 93,734	7,457,711
1905	[e] 6,989,492	[e] 182,749	[j] 111,477	7,100,969
1906	[e] 6,841,469	[e] 150,875	[j] 102,595	6,944,064
1907	[e] 4,138,189	[e] 93,895	[e] 61,971	4,200,160
1908	[e] 7,657,376	[e] 248,762	[e] 131,844	7,789,220
1909	[e] 6,577,836	[e] 194,273	[e] 101,022	6,678,858
1910	[e] 5,402,257	[e] 118,800	[e] 64,152	5,466,409
1911	[e] 7,439,874	[e] 203,755	[e] 107,990	7,547,864
1912	[e] 7,891,370	[e] 206,460	[e] 126,973	8,018,343
1913	[e] 7,319,294	[e] 172,702	[e] 104,312	7,423,606
Total	177,954,132	5,656,027	4,115,991	182,070,123

[a] Black Hills, S. Dak., by the Black Hills Mining Men's Association, 1904.
[b] Emmons, S. F., Progress of the precious-mineral industry in the United States since 1880; U. S. Geol. Survey Mineral Resources, 1892, p. 71, 1893: Estimate of the Director of the Mint.
[c] A canvass of the mines by the Eleventh Census gives $3,091,137.
[d] U. S. Geol. Survey Mineral Resources: Estimated by the Director of the Mint.
[e] U. S. Geol. Survey Mineral Resources: Collected by the United States Geological Survey from the mines.
[f] Report of the Director of the Mint for 1880, p. 192, gives for the fiscal year 1879: Gold, $2,420,000; silver, $10,000.
[g] Report of the Director of the Mint for 1880, p. 162, records first output (in latter part of 1879) of silver from the Florence silver chlorination mill and of shipments to Omaha of silver ore.
[h] Due to production of Iron Hill lead-silver mine. Report Director of the Mint for 1887, p. 197.
[i] Due to the treatment at the Deadwood and Delaware smelter of accumulated silver-bearing ore (of the Golden Reward mine) not desirable to treat by chlorination process. Franklin R. Carpenter, Report Director of the Mint for 1900, p. 185.
[j] Previous figures of U. S. Geol. Survey give, respectively, $92,522, $110,381, $101,086.

Source of gold and silver production in South Dakota in 1913.

Source.	Number of mines.	Tonnage.	Gold.		Silver.		Total value.
			Quantity.	Value.	Quantity.	Value.	
Deep mines:		*Short tons.*	*Fine ounces.*		*Fine ounces.*		
Siliceous ore	19	1,899,139	354,000.96	$7,317,849	172,417	$104,140	$7,421,989
Lead ore	1	28	2.50	52	277	167	219
Total	20	1,899,167	354,003.46	7,317,901	172,694	104,307	7,422,208
Placer mines	10		67.39	1,393	8	5	1,398
Grand total	30	1,899,167	354,070.85	7,319,294	172,702	104,312	7,423,606

MINING INDUSTRY IN 1913.

CONDITIONS.

The Homestake mines and mills were operated continuously in 1913. The salvable parts of the Mogul Mill at Pluma, which was burned in March, 1912, were removed to the mine at Terry, where a new mill was being erected in 1913. The Lundberg, Dorr & Wilson custom mill, which has been operated since 1904, closed in August, and the Buxton and Bonanza mines of this company were also closed. The Golden Reward, New Reliance, and Trojan mills were operated continuously. The Wasp No. 2 mill was operated for 8.3 months, and the new Bismarck mill was operated from March throughout the year.

Placer production in the Black Hills was confined to small desultory sluicing operations, chiefly in Pennington County. The dredge at Mystic was not operated.

REDUCTION MILLS.

List of reduction mills in South Dakota in 1913, by counties.

Name.	Location.	Process.	Equipment.	Approximate maximum capacity per day.
Custer County				*Short tons.*
Ruberta [a]	Custer	Amalgamation and cyanidation.	10 stamps, with cyanide annex, 2 percolation tanks.	30–40
Ruby [a]	do	Amalgamation and concentration.	Gates crusher, 10 stamps, 2 Frue vanners, 2 concentrating tables.	30
Lawrence County:				
Standard [a]	Cyanide	Cyanidation	1 Gates No. 4 crusher, 2 roller mills, 4 tanks.	100
Dakota [a]	Deadwood	do	30 stamps, wet-crushing; tanks	100
Golden Reward. [b c]	do	do	1 Gates crusher, 2 Chilean mills, 2 Huntington mills, 2 Akins, and 2 drag classifiers, 4 Dorr thickeners, 15 tanks (9 percolation, 6 agitation), Moore process. Steel ore bins added 1913.	150
Hidden Fortune. [a]	do	do		300

[a] Idle, 1913. [b] Active, 1913. [c] For description, see Min. and Eng. World, June 7, 1913, pp. 1103–1104.

List of reduction mills in South Dakota in 1913, by counties—Continued.

Name	Location.	Process.	Equipment.	Approximate maximum capacity per day.
Lawrence County—Continued.				*Short tons.*
Imperial [a]	Deadwood	Cyanidation	Blake crusher, Davis rolls, sampler, drier, 4 leaching tanks, dry-crushing.	125
Branch Mint [a]	Galena	do	120 stamps	400
Clover Leaf [a]	do	Amalgamation	60 stamps, plate amalgamation	240
Gilt Edge [a]	do	Concentration	1 Gates crusher, McFarlane rolls, Cone classifiers, 2 Monell slimers, 12 Monell concentrating tables.	150
Rattlesnake Jack. [b]	do	Cyanidation	10 stamps, Hardinge rolls, fine grinding, zinc precipitation.	50
Homestake [c d]	Lead	Amalgamation and cyanidation.	6 wet-crushing stamp mills aggregating 1,020 stamps, 20 Gates crushers, 3 tube mills, 131 Cone and 2 Dorr classifiers, 1 Dorr thickener, 2 cyanide sand plants (capacity, 75,000 tons a month), 1 cyanide slime plant (capacity 55,000 tons a month), 25 percolation tanks, 28 Merrill filters.	4,200
Lucky Strike [a]	Maitland	Cyanidation	Stamps, tanks	150
Minnesota [a]	do	do	2 roughing rolls, 2 slow-speed Chilean mills, tanks.	150
North Homestake. [a]	do	do	40 stamps, Cone classifiers, 8 slime and 6 sand tanks, cyanidation by agitation and percolation.	150
Safe investment. [a]	Novak	do	40 stamps, concentrating tables, cyanide annex.	200
Hawkeye [a]	Pluma	Amalgamation and cyanidation.	2 old mills, 40 and 60 stamps	160
Mogul (new) [b]	Terry	Cyanidation	Gyratory crushers, rolls, 2 Chilean mills, 1 tube mill, and 3 Dorr classifiers; continuous decantation and counter-current treatment of slime, using 4 Dorr thickeners, and eliminating the filters.	150
Puritan [a]	do	Concentration and cyanidation.	20 stamps, 2 Dorr classifiers, Wilfley tables.	240
Imperial [a]	Portland	Cyanidation	30 stamps	100
Victoria [a e]	do	do	1(5–K)and 1(3–D)Gates crusher, Davis rolls, Allis-Chalmers rolls, trommels, 5 tanks, dry-crushing and leaching.	200
Lexington Hill [a]	Spruce Gulch	Amalgamation and cyanidation.	20 stamps, Barr amalgamator, Wilfley tables, leaching tanks.	100
Lundberg, Dorr and Wilson. [d]	Terry	Cyanidation	Chilean mill, No. 4 Gates crusher, 1 Dorr classifier, 1 Dorr thickener, 4 sand tanks (110 tons); 4 percolation, 1 agitation tank; Moore process.	100–130
New Reliance [d]	Trojan	do	1 Gates crusher, 30 stamps, 1 Dorr classifier, 4 Dorr thickeners, sand and slimes separated, sands leached, slimes treated by continuous counter-current decantation, 5 slime tanks, 1 Portland filter.	120
Trojan [d]	do	do	1 Gates No. 5–K crusher, 2 7-foot Chilean mills, 1 Dorr thickener, 2 Dorr duplex classifiers, 5 sand tanks (capacity, 925 tons dry sand), 5 percolation, 3 air-agitation tanks, 1 stationary leaf-type filter.	200
Golden Crest [a]	Two Bit	do	40 stamps, 3 Dorr classifiers, 2 Dorr thickeners, tube mill; all-sliming, Moore filter process.	200
Bismarck [d f]	Yellow Creek (Flat Iron).	do	1 (5–K) and 2 (3–D) Gates crushers, 2 sets roller mills, Allis-Chalmers "A" 6 tanks. Dry crushing and leaching.	260

[a] Idle, 1913.
[b] Building, 1913.
[c] Clark, A. J., and Sharwood, W. J., Metallurgy of the Homestake ores: Inst. Min. and Met. Bull. 98, Nov. 14, 1912. Abstracted, Eng. and Min. Jour., Jan. 18, 1913, pp. 161–166, and Jan. 25, 1913, pp. 5–219; 21; also Min. and Eng. World, Dec. 7, 1912, pp. 1035–1039, and Dec. 14, 1912, pp. 1090–1094, and Dec. 21, 1912, pp. 1142–1147, and Dec. 28, 1912, pp. 1189–1192; also Min. and Sci. Press, Jan. 11, 1913, p. 108; also Met. and Chem. Eng., Jan., 1913, p. 50.
[d] Active, 1913.
[e] For description, see Min. and Eng. World, Sept. 28, 1912, p. 571.
[f] For description, see Min. and Sci. Press, Feb. 22, 1913, p. 320.

List of reduction mills in South Dakota in 1913, by counties—Continued.

Name.	Location.	Process.	Equipment.	Approximate maximum capacity per day.
Lawrence County—Continued.				*Short tons.*
Wasp No. 2 [a] [b].	Yellow Creek. (Flat Iron.)	Cyanidation	Steam shovel for stripping, 4 Gates crushers, 4 McFarlane rolls, 6 percolation tanks. Dry crushing and leaching.	500
Pennington County:				
Black Tom [c]	Castle Creek	Amalgamation	2 crushers, 10 stamps. Overhauled 1912.	20
Hymalulu [c]	do	do	2 stamps	15
Inca [d]	do	Amalgamation, concentration, cyanidation.	10 stamps, plates, Wilfley tables, tanks. Uncompleted.	40
James G. Blaine. [c]	do	Amalgamation	1 Chilean mill	8
Canton [c]	Hill City	do	25-ton Chilean mill, plates, concentrating tables.	75
Golden Summit. [b]	do	do	1 Blake crusher, 10 stamps, plates	30
Slipper [c]	do	do	5 stamps. To build cyanide plant	15–20
Bismarck [c]	Keystone	Amalgamation, concentration, and cyanidation.	Gates No. 3 crusher, 20 stamps, Isbell classifier, Wilfley No. 3 table, 3 Wilfley slimers; 6 tanks, agitation and percolation; 2 filters.	80–90
Otho [d]	do	Amalgamation, and concentration.	3 crushers, 3 Chilean mills, 3 roller mills, 6 Wilfley tables, Frue vanners. Completed, 1914.	100
Holy Terror [c]	do	do	1 20-stamp concentration mill, 1 15-stamp concentration mill, 1 cyanide mill.	80
Tykoon [c]	do	do	10 stamps, 1 classifier, 2 Wilfley and 1 slime concentration tables.	40
Forest City (Clara Belle) [c]	Oreville	Amalgamation and cyanidation.	10 stamps, cyanide tanks	50
Silver City [c]	Rapid Creek	Amalgamation	Huntington mill	20–25
Cochran [c]	Rochford	do	do	20
Gold King (Gordelia). [c]	do	do	1 crusher, 10 stamps, plates	40
Golden West [c]	do	do	Chilean mill, amalgamating plates	50
North Star [c]	do	do	25-ton Chilean mill, amalgamating plates.	75
Stanby [c]	do	do	60 stamps	80–240

[a] For description, see Min. and Eng. World, Jan. 4, 1913, p. 11; also Min. and Eng. World, May 3, 1913, p. 849.

[b] Active, 1913. [c] Idle, 1913. [d] Building, 1913.

REVIEW BY COUNTIES.

CUSTER COUNTY.

Mine production of gold, silver, and copper in Custer County, S. Dak., from 1904 to 1913.

Year.	Number of mines producing.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1904	4	1,900	$6,491	121	.....	$6,560
1905	5	16	706	3	38	714
1906	2	16	687	3	.....	689
1907	1	33	332	3	.....	334
1908	2	470	1,533	4	.....	1,535
1909	1	400	1,311	21	.....	1,322
1910	.....	.....	.....	.....	.....	.....
1911	5	.....	309	4	.....	311
1912	5	75	1,187	3	.....	1,189
1913	5	5	194	1	1,503	428
Increase (+) or decrease (−) for 1913	.....	−70	−993	−2	+1,503	−761

[a] Includes both deep and placer mines.

A small lot of oxidized copper ore was shipped from the Southern Queen group mine, near Custer. This mine is opened by a 30-foot shaft and 250 feet of drifts. A small yield of placer gold was recovered by sluicing and rocker, near Custer. Assessment and development work was done on several lode claims near Custer.

LAWRENCE COUNTY.[1]

Mine production of gold, silver, copper, and lead in Lawrence County, S. Dak., from 1904 to 1913.

Year.	Number of mines producing.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	44	1,801,524	$7,346,986	161,216	.....	.....	$7,439,282
1905	19	1,826,177	6,955,690	182,597	.....	.....	7,065,979
1906	27	1,771,377	6,816,196	150,537	.....	22,719	6,918,351
1907	22	1,470,154	4,134,667	93,830	.....	.....	4,196,595
1908	17	1,927,844	7,650,523	248,686	.....	23,046	7,783,295
1909	17	1,699,260	6,561,628	191,044	3,977	1,512	6,661,553
1910	19	1,522,986	5,380,795	118,716	.....	14,136	5,445,523
1911	16	1,940,719	7,408,356	203,350	.....	64,311	7,519,025
1912	19	1,901,310	7,875,401	206,356	.....	22,845	8,003,338
1913	20	1,899,162	7,317,320	172,688	290	10,205	7,422,117
Increase (+) or decrease (−) for 1913	+1	−2,148	−558,081	−33,668	+290	−12,640	−581,221

[a] Includes both placer and deep mines.

Output of Homestake mine, 1909–1913, inclusive.

Year.	Ore milled.	Bullion recovered.	Value per ton.	Dividends.
	Short tons.			
June 1, 1909, to June 1, 1910	1,237,381	$4,498,751	$3.6357	$982,900
June 1, 1910, to June 1, 1911	1,468,263	5,251,454	3.5766	1,310,400
June 1, 1911, to December 31, 1911	888,057	3,601,152	4.1205	764,400
Calendar year 1912	1,528,923	6,600,953	4.3174	1,310,400
Calendar year 1913	1,540,961	6,186,652	4.0148	2,146,224

For the calendar year 1913 the Homestake Co.'s public report shows that in 1913 development covered 16,313 feet of drifts and 686 feet of rises. The depths of the shafts remain as they were a year ago, namely, Ellison, 1,850; B. and M., 1,550; Golden Prospect, 1,100; Golden Star, 1,400; Old Brig, 800; and Golden Gate, 800 feet. Broken ore in the stopes amounts to 2,206,671 tons, an increase of 176,000 tons.[2]

In the Bald Mountain area and the Portland district the Golden Reward group was operated continuously, both on company account and by lessees, and oxidized ore was shipped to the company's mill near Deadwood and to the smelter at Omaha. This company com-

[1] For information on the geology of this county see Irving, J. D., Ore deposits of the northern Black Hills: U. S. Geol. Survey Bull. 225, pp. 133–140, 1904. Irving, J. D., and Emmons, S. F., Economic resources of northern Black Hills: U. S. Geol. Survey Prof. Paper 26, pp. 53–212, 1904.

[2] Min. Mag. (London), April, 1914, p. 268. See also Eng. and Min. Jour., Apr. 4, 1914, p. 715; and Min. and Eng. World, Mar. 14, 1914, p. 527.

pleted the erection of a 75-ton Wedge roaster at its Astoria shaft early in the year, and experimented with the roasting of the sulphide or "blue" ores, as a preliminary treatment before cyanidation.[1] The Golden Reward mill also treated some custom ore. The Lundberg, Dorr & Wilson mill was closed in August, having been operated since 1904. The Buxton and Bonanza mines of this company were also closed.[2] This mill, up to the time of closing, treated ore from the Buxton and Bonanza, Mogul, and Dakota mines. The Mogul Co. was also occupied in building a new mill at the mine at Terry to replace the old mill at Pluma, burned in March, 1912. The new mill will be of the continuous counter current decantation type without the use of filters, and will not be completed until 1914. The Trojan mine and mill were operated steadily. A considerable tonnage of smelting ore from this mine was sent to Omaha. The New Reliance mine and mill were operated continuously. At this mine diamond drills have been installed for prospecting.

In the Bear Butte (or Galena) district siliceous gold ore was shipped from the Rattlesnake Jack mine to custom mills and to smelters. A 50-ton cyanidation mill was under construction on this property during the year. The Black Hills Smelting Co.'s semi-pyritic smelter remained inoperative. The 150-ton dry-crushing concentration mill of the Gilt Edge Consolidated Mining Co. was also idle. The mine of this company is opened by a 220-foot shaft, 1,600 feet of drifts, and an adit 1,450 feet long. The New Silver Queen Mining Co. was occupied in reopening its mine, an old property worked 17 years ago.

Several cars of ore carrying appreciable quantities of gold and silver were shipped from the Monarch mine, situated between Two-Bit and Whitewood gulches.

Some development work was done in the Custer Peake district near Roubaix.

A car of ore from the Old Ironsides mine, in the Carbonate district, was shipped to the Golden Reward mill.

In the Maitland district several cars of ore were shipped to Colorado smelters from the Golden Gate and Colorado-Deadwood mines. Development work was done on several properties.

In the Yellow Creek area the dry-crushing cyanidation plant of the Wasp No. 2 Mining Co. was operated for 8.3 months of the year. The ore is mined by the open-cut system, a steam shovel being used for stripping. The public annual report of this company shows that during 1913 there were 127,680 tons of ore treated, from which the returns were $200,000 in gold and $19,000 in silver. The costs of operation were—mining, $0.6363 per ton; milling, $0.6305 per ton; general, $0.0442 per ton; total, $1.31 per ton.[3] The 260-ton dry-crushing cyanidation plant of the Bismarck Co., erected in 1912, was almost continuously operated from March 15, 1913, to end of year.

[1] Simmons, Jesse, Min. and Sci. Press, Jan. 4, 1913, p. 80, on the subject of roasting these ores. See also U. S. Geol. Survey Mineral Resources for 1908, pt. 1, p. 535, 1909.
[2] For history of this property see Min. and Sci. Press, Aug. 23, 1913, p. 315.
[3] Min. and Eng. World, Mar. 14, 1914, p. 527.

PENNINGTON COUNTY.

Mine production of gold, silver, and copper in Pennington County, S. Dak., from 1904 to 1913.

Year.	Number of mines producing.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1904	16	1,511	$10,500	274	.....	$10,657
1905	8	11,218	33,096	149	.....	33,186
1906	6	9,281	24,586	335	.....	24,810
1907	7	969	3,190	62	.....	3,231
1908	8	1,235	5,320	72	.....	5,358
1909	13	4,481	14,897	3,208	114,408	31,438
1910	7	943	21,462	84	.....	21,508
1911	16	5,408	31,209	401	.....	31,422
1912	16	341	14,782	101	.....	14,844
1913	5	.....	1,780	13	.....	1,788
Increase (+) or decrease (−) for 1913	−11	−341	−13,002	−88	.....	−13,056

[a] Includes both deep and placer mines.

Near Mystic, on Castle Creek, the Castle Creek Hydraulic Gold Mining Co.'s dredge remained inoperative since its closing in September, 1912. Some development work was done on the Black Tom, Inca, and James G. Blaine properties.

At Hill City, assessment and development work was done on the Antlers, Black Hills-Anaconda, Golden Slipper, and Forest City properties and on that of the Hill City Mining & Development Co. Some high-grade gold was taken from a small "pocket" in the Golden Summit mine. Toward the end of the year preparations were made for reopening the Dakota-Calumet property, from which some copper ore has been extracted in the past, and in 1914 work was commenced on deepening the shaft. There is a blast furnace at this mine.

In the Hornblende district, near Rochford, development work was done on the Gordelia property.

At Keystone, considerable development work was done, and a 100-ton mill was completed on the property of the Otho Development & Power Co. The deposit is reported to contain lead ore of smelting grade carrying gold and silver and a gold ore suitable for milling. Assessment work was done on several lode and placer claims in this district.

Several small sluice mines were operated on Battle, Rapid, and Spring creeks.

BIBLIOGRAPHY.

CARPENTER, F. R., Notes on the geology of the Black Hills: Preliminary report of the Dakota School of Mines upon the geology, mineral resources, and mills of the Black Hills of Dakota, Rapid City, 1888.

CROSBY, W. O., Geology of the Black Hills of South Dakota: Boston Soc. Nat. Hist. Proc., vol. 23, pp. 488–517, 1888; vol. 24, p. 11.

EMMONS, S. F., Progress of the precious-metal industry in the United States since 1880: U. S. Geol. Survey Mineral Resources for 1891, pp. 46–94, 1892.

HAYDEN, F. V., Geological report of the exploration of the Yellowstone and Missouri rivers, 1859–60, 1869, p. 42.

HENDERSON, C. W., Gold, silver, copper, lead, and zinc (mine production) in South Dakota: U. S. Geol. Survey Mineral Resources for 1912, pt. 1, pp. 867–875, 1913.
HILL, J. M., Mining districts of the western United States: U. S. Geol. Survey Bull. 507, 309 pp., 1912.
IRVING, JOHN DUER, A contribution to the geology of the northern Black Hills: New York Acad. Sci. Annals, vol. 12, No. 9, p. 187 et seq.
JAGGAR, T. A., jr., The laccoliths of the Black Hills, with a chapter on experiments illustrating intrusion and erosion, by Ernest Howe: U. S. Geol. Survey Twenty-first Ann. Rept., pt. 3, p. 163, 1900.
LINDGREN, WALDEMAR, The production of gold in the United States in 1904: U. S. Geol. Survey Bull. 260, pp. 32–38, 1905.
——— The production of silver in the United States in 1904: Op. cit., pp. 39–44.
——— A geological analysis of the silver production of the United States in 1906: U. S. Geol. Survey Bull. 340, pp. 23–35, 1908.
——— Resources of the United States in gold, silver, copper, lead, and zinc: U. S. Geol. Survey Bull. 394, pp. 114–156, 1909.
MCCASKEY, H. D., Gold and silver: Mineral resources for 1912, pt. 1, pp. 225–273, 1913.
NEWTON, HENRY, and JENNEY, WALTER P., Report on the geology and resources of the Black Hills of Dakota: U. S. Geog. and Geol. Survey, Rocky Mtn. Region, pp. 225–300, 1880.
WARREN, G. K., Explorations in Nebraska and Dakota in 1855, 1856, 1857: Engineer Corps, U. S. A., p. 30, 1875.
WINCHELL, N. H., Geological report on the Black Hills: Report on a reconnaissance of the Black Hills of Dakota made in the summer of 1874, by William Ludlow, captain of engineers, U. S. A., pp. 17, 37, 1875.

WYOMING.

By CHARLES W. HENDERSON.

PRODUCTION.

The total value of the production of gold, silver, and copper in the State of Wyoming in the calendar year 1913 was $84,474, an increase of $57,527 over that of 1912. The gold and silver yields increased somewhat, and the copper output increased considerably. There were 15 producing mines, of which 6 were deep and 9 were placer.

The quantity of ore sold or treated was 4,236 short tons, as compared with 2,439 tons in 1912. The output of siliceous ore increased from 2,284 tons in 1912 to 3,272 tons in 1913, and that of copper ore increased from 155 tons in 1912 to 964 tons in 1913. Deep mines yielded $22,777 in gold, 942 fine ounces of silver, and 385,239 pounds of copper. Placer gold production amounted to $1,407 in 1913, as compared with $766 in 1912.

The copper yield represented nearly 71 per cent of the State total value in 1913, gold representing nearly 29 per cent.

Mine production of gold, silver, and copper in Wyoming in 1912 and 1913.

Year.	Tonnage.	Gold.[a]		Silver.[a]		Copper.		Total value.
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Short tons.	*Fine ounces.*		*Fine ounces.*		*Pounds.*		
1912	2,439	1,075.62	$22,235	265	$163	27,570	$4,549	$26,947
1913	4,236	1,169.90	24,184	957	578	385,239	59,712	84,474
Increase (+) or decrease (−)	+1,797	+94.28	+1,949	+692	+415	+357,669	+55,163	+57,527

[a] Includes placer production.

The following table shows the total output of gold, silver, and copper in Wyoming since 1867:

Production of gold, silver, and copper in Wyoming from 1842 to 1913, inclusive.

Year.	Gold.	Silver.		Copper.		Total value.
	Value.	Fine ounces.	Commercial value.[g]	Pounds.[s]	Value.	
1842–1867	[a] Small unknown.					
1867	[a] $8,600	[o] 70	$90			$8,690
1868	[a] 77,500	[o] 620	802			78,302
1869	[a] [c] 155,000	[o] 1,240	1,603			156,603
1870	[b] [c] 155,000	[o] 1,240	1,603			156,603
1871	[c] 155,000	[o] 1,240	1,603			156,603
1872	[d] 100,000	[o] 800	1,034			101,034
1873	[e] 50,000	[o] 400	517			50,517
1874	[f] 25,000	[o] 200	259			25,259
1875	[g] 10,000	[m] 100	124			10,124
1876	[h] 10,000	[m] 100	116			10,116
1877	[h] 10,000	[m] 100	120			10,120
1878	[h] 10,000	[m] 100	115			10,115
1879	[h] 10,000	[m] 100	112			10,112
1880	[i] 20,000	[m] 100	115			20,115
1881	[j] 5,000	[m] 100	113			5,113
1882	[j] [k] 5,000	[m] 240	274	[u] [w] 100,000	$19,100	24,374
1883	[j] 4,000	[m] 1,440	1,598	[v] [w] 962,468	158,807	164,405
1884	[j] 6,000	[m] 100	111			6,111
1885	[l] 10,000	[m] 100	107			10,107
1886	[m] 7,500	[m] 100	99			7,599
1887	[m] 7,500	[m] 100	98			7,598
1888	[m] 7,500	[m] 420	395	[w] 232,819	39,114	47,009
1889	[m] 7,500	[m] 240	226	[w] 100,000	13,500	21,226
1890	[m] 7,500	[m] 100	105			7,605
1891	[m] 7,500	[m] 100	99			7,599
1892	[m] 7,500	[m] 100	87			7,587
1893	[m] 7,500	[m] 100	78			7,578
1894	[m] 7,500	[m] 100	63			7,563
1895	[m] 7,500	[m] 100	65			7,565
1896	[j] 14,300	[j] 100	68			14,368
1897	[j] 11,200	[j] 100	60			11,260
1898	[j] 5,300	[j] [p] 100	59	[x] 233,044	28,897	34,256
1899	[j] 29,200	[j] [p] 400	240	[x] 3,104,827	530,925	560,365
1900	[j] 34,200	[j] 200	124	[x] 4,203,776	697,827	732,151
1901	[j] 12,700	[j] [p] 21,400	12,840	[y] 2,698,712	450,685	476,225
1902	[j] 38,800	[j] 5,000	2,650	[y] 889,228	108,486	149,936
1903	[j] 3,600	[j] [p] 200	108	[y] 1,023,189	140,177	143,885
1904	[n] 17,305	[n] 4,647	[r] 2,695	[t] [x] 3,565,629	456,401	476,401
1905	[n] 26,745	[n] 3,655	[r] 2,230	[t] [y] 2,530,531	394,763	423,738
1906	[n] 6,521	[n] 136	[r] 92	[t] [x] 106,177	20,492	27,105
1907	[n] 9,344	[n] 3,715	2,452	[t] [z] 3,026,004	605,201	616,997
1908	[n] 7,959	[n] 3,998	2,119	[a] [a] [t] 2,416,197	318,938	329,016
1909	[n] 4,086	[n] 1,754	912	[bb] [t] 433,672	56,377	61,375
1910	[n] 3,199	[n] 1,478	798	[cc] [t] 217,127	27,575	31,572
1911	[n] 19,200	[n] 725	384	[dd] [t] 130,499	16,312	35,896
1912	[n] 22,235	[n] 265	163	[ee] [t] 25,080	4,138	26,536
1913	[n] 24,184	[n] 957	578	[ff] 385,239	59,712	84,474
Total	1,191,178	58,680	40,303	26,383,318	4,147,427	5,378,908

[a] Raymond, R. W., Mining statistics west of the Rocky Mountains for 1869, 1870. The Sweetwater district, Wyoming, pp. 325–328.

[b] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1870, 1872. Wyoming, pp. 334–335.

[c] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1871, 1873. Wyoming, pp. 372–376.

[d] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1872, 1873. Wyoming, pp. 306–307, see also p. 3.

[e] Raymond, R. W., Mineral resources west of the Rocky Mountains for 1874, p. 8, 1875.

[f] Estimate by Charles W. Henderson. See Raymond, R. W., idem, pp. 7–8.

[g] Estimate by Charles W. Henderson. See Raymond, R. W., Mineral resources west of the Rocky Mountains for 1875, p. 335, 1877. "Sweetwater district nearly idle." The total gold for 1867–1875 ($736,100) represents the output of the Sweetwater (Atlantic City, South Pass, Leviston) district. These figures are much lower than generally quoted. They are the figures of Rossiter W. Raymond, who has explained in his reports herein quoted the manner in which he collected them. The source of the generally quoted figures ($5,050,000) is W. C. Knight (The mining districts in Wyoming: Wyoming Univ., Agr. Coll. Dept., Bull. 14, October, pp. 123–124, 1893), but Knight says: "The only estimate of the output from this region is one which has been generally circulated, but upon what basis the estimate is made or who is the author I am unable to find out." Henry C. Beeler, former State geologist (Mineral resources of Wyoming, pp. 13–19, State Board of Immigration, Cheyenne, Wyo., 1907), says: "The amount of gold produced from 23 properties in this district since its discovery is $3,728,000." The gold from placers in the early days

Source of mine production of gold and silver in Wyoming in 1912 and 1913.

Source.	Number of mines.	Tonnage.	Gold.		Silver.		Total value.
			Quantity.	Value.	Quantity.	Value.	
Deep mines:		*Short tons.*	*Fine ounces.*		*Fine ounces.*		
Siliceous ore	4	3,272	1,101.84	$22,777	111	$67	$22,844
Copper ore	2	964	.....	.....	831	502	502
Total deep mines, 1913	6	4,236	1,101.84	22,777	942	569	23,346
Deep mines, 1912	8	2,439	1,038.56	21,469	263	162	21,631
Increase (+) or decrease (−)	−2	+1,797	+63.28	+1,308	+679	+407	+1,715
Placer mines, 1913	9	.....	68.06	1,407	15	9	1,416
Placer mines, 1912	9	.....	37.06	766	2	1	767
Increase (+) or decrease (−)	.....	.....	+31.00	+641	+13	+8	+649
Total deep and placer mines, 1913	15	4,236	1,169.90	24,184	957	578	24,762

of the district * * * can only be estimated and is placed at from $2,000,000 to $3,000,000;" and (on p. 3) he adds: "Gold mines were first worked at South Pass, Fremont County, in 1867, since which date the industry has amounted to something each year. The annual production has fluctuated from $25,000 to $125,000, the total being estimated at $1,000,000." Mr. Beeler (oral communication) says these figures are borne out by statements of some of the old residents of this district, including stage drivers, bankers, etc. C. E. Jamison, State geologist (Geology and mineral resources of a portion of Fremont County, Wyo., Bull. 2, series B, p. 80, Cheyenne, 1911), gives "estimated output of the mines of the South Pass district as $5,863,000."

The earliest report at hand is that of Samuel Aughey (Ann. Rept. Territorial geologist to the governor of Wyoming, January, 1886, pp. 12-15, Laramie, Wyo., 1886), who says: "Placer grounds on Spring Gulch, at Miner's Delight, are still successfully worked every spring while the water lasts. Up to date these grounds have yielded over $400,000 in gold. The Miner's Delight * * * when worked in the palmy days of mining * * * produced at least $200,000."

Other publications reviewed are as follows:

Warren, F. E., Rept. Governor of Wyoming to the Secretary of the Interior, 1885, p. 1148.

Ricketts, L. D., Ann. Rept. Terr. Geologist to the Governor of Wyoming, 1888, pp. 60-72; idem, 1890, pp. 73-78.

Beeler, H. C. (State geologist), A brief review of the South Pass gold district, Fremont County, Wyo., 18 pp., Nov. 1, 1908.

h Estimate by Charles W. Henderson. Based on opening of placers in Wyoming adjacent to Black Hills, S. Dak.

i Burchard, H. C., Rept. Director Mint for fiscal year 1880, p. 8, 1881.

j Mineral resources U. S., U. S. Geol. Survey. Estimate of the Director of the Mint.

k See Burchard, Rept. Director Mint, p. 594.

l Estimate by Charles W. Henderson, partly by elimination of production of other States.

m Estimate by Charles W. Henderson.

n Mineral Resources U. S., U. S. Geol. Survey. Collected by the U. S. Geological Survey from the mines.

o Estimated on basis of fineness of gold and silver, Sweetwater district.

p A knowledge of the quantity of silver in the copper ore of the Encampment district shows that the figures for silver are too low for 1898, 1899, 1900, and 1903, the balance giving a high output of silver for the State for these four years; the figures are too high for 1901.

q Except for the period 1867-1874, inclusive, when coining value ($1.2929) was approximately commercial value.

r Previous figures of the U. S. Geological Survey are, respectively, $2,661, $2,208, and $91.

s From Copper, Mineral Resources United States, U. S. Geological Survey, being copper output as reported from smelters and refineries.

t The copper output as reported by the mines to the Survey for the years 1904-1912 is—

	Pounds.		Pounds.
1904	3,527,008	1910	222,339
1905	2,394,008	1911	118,584
1906	24,000	1912	27,570
1907	2,257,650		
1908	2,452,049	Total	11,515,747
1909	492,539		

The smelter figures are 12,450,916 pounds.

u See Kirchhoff, C., jr., The copper industry of the United States: U. S. Geol. Survey, Mineral Resources, for 1881-82, p. 216 (for output), p. 229 (for history of discovery of copper in the State), 1883.

v For figures see op. cit. for 1883-84, p. 329, U. S. Geol. Survey, 1885.

w From Hartville district, Laramie County.

x From Encampment district, Carbon County, showing beginning in 1898.

y From Encampment district and Douglas Creek (Holmes, New Rambler) district (in Albany County adjoining), showing beginning of output of New Rambler property.

z Encampment, Douglas Creek, Hartville, and Copper Mountain.

aa Encampment, Hartville, and Copper Mountain.

bb Encampment and Hartville.

cc Douglas Creek and Copper Mountain.

dd Encampment, Douglas Creek, and Hartville.

ee Douglas Creek and Hartville.

ff Hartville.

MINING INDUSTRY IN WYOMING IN 1913.

The principal producing mining district in Wyoming in 1913 was the Atlantic City (or South Pass) district, Fremont County, with output in mill bullion, cyanide precipitates, and placer bullion. Copper ore was shipped from Hartville, Platte County. A small quantity of placer gold was also recovered in Hurricane district, Crook County, in the district south of Rawlins, Carbon County, and in the Porcupine Creek district, near Cloverly, Big Horn County. Development work of interest was done in the Bear Lodge district, Crook County, in the Atlantic City district, Fremont County, and in the Big Horn Mountains district, in Big Horn and Johnson counties.

REVIEW BY COUNTIES.

In the following review the footnote references indicate publications containing information on the geology of the respective regions.

ALBANY COUNTY.[1]

The Rambler property, at Holmes, from which considerable copper ore has been shipped, was idle in 1913. Assessment and development work was done on several claims in the Centennial district.

The following table shows the production of Albany County for those years for which figures are available:

Production of gold, silver, and copper in Albany County,[a] Wyo., 1868–1913.

Year.	Tonnage.	Gold.		Silver.	Copper.
		Placer.	Deep mines.		
	Short tons.			*Fine ounces*	*Pounds.*
1868–1893		[b] $40,000	[b] $189,000		
1901–1912		[c] 945			
1901–1903					[c] 900,532
1907					[c d] 24,350
1909–1912	[c e] 3,071		[c] 2,108	[b] 3,213	[c] 700,567
1913					
Total					1,625,449

[a] Chiefly Douglas Creek district.
[b] Knight, W. C., The mining districts of Albany County: Wyoming Univ. Agr. College Dept. Bull. 14, October, 1893, p. 128. (Probably too high, considering total production of Wyoming for these years.
[c] Mineral Resources records.
[d] Beeler, H. C., Mineral Resources of Wyoming, State Board of Immigration, Cheyenne, Wyo., 1907, p. 27, gives 828,700 pounds for production of the Rambler mine to date (1907).
[e] For one year tonnage of concentrates used instead of crude ore, giving therefor tonnage and contents of material smelted. The concentrates were little better than the original crude ore.

BIG HORN COUNTY.[2]

A small quantity of placer gold was recovered by sluicing operations for three months on Porcupine Creek, near Cloverly.

Some development work was done on lode claims in this county, in the Bighorn Mountains, near the Johnson County line.

[1] Emmons, S. F., Platinum in copper ores in Wyoming: U. S. Geol. Survey Bull. 213, pp. 94–97, 1903. Kemp, J. F., Platinum in the Rambler mine, Wyoming: U. S. Geol. Survey, Mineral Resources for 1902, pp. 244–250, 1904. Platinum in Wyoming: Eng. and Min. Jour., Mar. 4, 1911, p. 460. Concentration of platiniferous copper ore at the Rambler mine, Wyo.: Metall. and Chem. Eng., February, 1911, pp. 75–78.
[2] Darton, N. H., U. S. Geol. Survey, Geol. Atlas, Bald Mountain-Dayton folio (No. 141) and Cloud Peak-Forth McKinney folio (No. 142), 1906; Geology of the Bighorn Mountains: U. S. Geol. Survey Prof. Paper 51, 1906. Fisher, C. A., Geology and water resources of Bighorn Basin, Wyo., U. S. Geol. Survey Prof. Paper 53, 1906.

CARBON COUNTY.[1]

A small quantity of placer gold was recovered from operations outh of Rawlins. Some assessment and development work was one on lode claims in the county, but most of the properties were nactive.

The Penn-Wyoming mines and smelter, near Encampment, rom which much of the copper output from Wyoming has come, vere idle.

The following table shows the production of the Encampment istrict from the year of first output, 1898, to 1913:

roduction of gold, silver, and copper in the Encampment[a] district, Carbon County, Wyo., from 1898 to 1913.

Year.	Tonnage.	Gold.	Silver.		Copper.		Total value.
			Fine ounces.	Commercial value.	Pounds.	Value.	
	Short tons.						
98	[b] 2,484	[b] $497	[b] 314	$185	[c] 233,044	$28,897	$29,579
99	[b] 33,095	[b] 6,619	[b] 4,183	2,510	[c] 3,104,827	530,925	540,054
00	[b] 44,808	[b] 8,962	[b] 5,663	3,511	[c] 4,203,776	697,827	710,300
01	[b] 28,766	[b] 5,753	[b] 3,636	2,182	[cd] 2,698,712	450,685	458,620
02	[b] 2,536	[b] 507	[b] 321	170	[cd] 237,892	29,023	29,700
03	[b] 8,250	[b] 1,650	[b] 1,043	563	[c] 773,993	106,037	108,250
04	41,370	6,593	4,483	2,600	[e] 3,527,008	451,457	460,650
05	28,039	4,678	3,549	2,165	[e] 2,385,628	372,158	379,001
06	60				[c] 24,000	4,632	4,632
07	25,950	4,802	2,982	1,968	[e] 2,206,065	441,213	447,983
08	18,851	6,181	3,123	1,655	[e] 2,367,666	312,532	320,368
09	150				[e] 33,431	4,346	4,346
10							
11	20		21	11	[e] 4,738	592	603
12		[f] 27					27
13		[f] 424	8	5			429
Total	234,379	46,693	29,326	17,525	21,800,780	3,430,324	3,494,515
verage per ton		$0.197	0.125 ounce.		93 pounds, or 4.65 per cent.		

[a] Including various small yields from other districts of Carbon County (being the output of Carbon unty).
[b] Estimated by Charles W. Henderson.
[c] Smelter figures.
[d] The Encampment production for 1901–2 is the total Wyoming copper production less the Douglas reek, Albany County, copper production. The Douglas Creek figures are available only for the two years mbined. This combined production has been subtracted from the total Wyoming production for 1902, ne being subtracted from the 1901 figures. In either event, the total pounds of copper produced in each mp would be unchanged.
[e] Mine figures.
[f] Placer output.

CONVERSE COUNTY.

At the Saul's Camp property, near Esterbrook, opened by a 90-foot haft, 30 feet of drifts, and 700 feet of diamond drill holes, it is reorted that some copper-sulphide ore, carrying also gold and silver, nd an iron-sulphide ore, carrying nickel, was stored in ore bins during evelopment work.

[1] Spencer, A. C., Mineral resources of the Encampment copper region, Wyoming: U. S. Geol. Survey ull. 213, pp. 158–162, 1903.
Speneer, A. C., Copper deposits of the Encampment district, Wyoming: U. S. Geol. Survey Prof. aper 25, 107 pages, 1904.
See also Spencer, A. C., Reconnaissance examination of the copper deposits at Pearl, Colo.: U. S. Geol. rvey Bull. 213, pp. 163–169, 1903.

CROOK COUNTY.

Sluicing in the Hurricane district, northwest of Tinton, S. Dak., resulted in a small placer output.

Considerable development work was done on properties in the Bear Lodge district,[1] near Sundance. A test run was made in the Huntington mill of the Reuter Co.

FREMONT COUNTY.

From 4 deep mines and 3 placers in the Atlantic City district there was a production in Fremont County of $23,276 in gold and 115 ounces of silver, valued at $69, as compared with $21,804 in gold and 146 ounces of silver, valued at $90, in 1912, with $18,672 in gold and $161 in silver for 1911, and with a total value of $1,786 in 1910 for the county.

Atlantic City (South Pass) district.—The production of gold in the Atlantic City district was 92 per cent, and of silver 15 per cent of the State totals for these metals. During 1911–13 there has been a reopening of the mines of this district, which was known as the Sweetwater district in 1842–1875.[2] At the Duncan mine, the 30-ton amalgamation-cyanidation mill was operated for 7 months on ore from stopes of the upper levels and from the dumps. This mine is opened by an incline (68 degrees) shaft, 280 feet deep, by 2,900 feet of drifts, one 190-foot adit, and one 225-foot adit for drainage. Oxidized ores extend to a depth of 170 feet. A small quantity of gold was extracted from the Big Chief mine. From the Hidden Hand property, near Grosvenor, opened by a 35-foot shaft, a laboratory test of several hundred pounds of ore yielded considerable gold. Some gold was recovered by sluicing in the district. Development work and unwatering of the property was done at the Carissa mine, which is opened by a 400-foot shaft, 4,000 feet of drifts, and 600 feet of crosscuts. The Monte Carlo is opened by a 100-foot shaft; the Glendale by a 112-foot shaft, 400 feet of drifts, and an adit 160 feet long; the Copper Surprise by a 500-foot shaft. Development work was started on the Jerry Dain and the Bobtail properties, and a mill is in prospect. The unwatering of the Miners Delight mine is in prospect.

Copper Mountain district.—Some development work was done in the Copper Mountain district in 1913, and the 3-stamp Merrill mill of the Gold Nugget property was tested early in 1914.

Dredges on Bighorn River and tributaries.—The Shoshoni Gold Dredging Co.'s Marion dredge of 61 buckets, closed down in 1912, was removed to Tincup, Gunnison County, Colo., in 1913.

JOHNSON COUNTY.[3]

Several tons of ore from the Kelly Creek property were tested at the 10-stamp mill, with Lounsberry amalgamator, in the Bull Camp district of Johnson County. Some development work was done in the Big Goose district, in the Big Horn Mountains.

---

[1] Darton, N. H., Geol. Atlas, U. S. Geol. Survey, Geol. Atlas, Sundance folio (No. 127), 1905.

[2] See note to table of production of gold, silver, and copper in Wyoming, 1842–1913.

[3] See Darton, N. H., U. S. Geol. Survey, Geol. Atlas, Bald Mountain-Dayton folio (No. 141) and Cloud-Peak-Fort McKinney folio (No. 142), 1906; also Geology of the Big Horn Mountains, U. S. Geol. Survey, Prof. Paper 51, 1906.

PARK COUNTY.

Some little development work was done in the Sunlight and Kirwin [1] districts of Park County.

PLATTE COUNTY.[2]

A considerable tonnage of silver-bearing copper ore was shipped from the Sunrise iron mine, near Sunrise, and several cars of copper ore were shipped from the Green Hope mine, in the Hartville district of Platte County.[3]

The following table shows the production of the Hartville district since its discovery in 1881:

Production of the Hartville district, Laramie County, Wyo., from 1882 to 1913.[a]

Year.	Tonnage.	Silver.		Copper.		Total value.
		Fine ounces.	Commercial value.	Pounds.	Value.	
	Short tons.					
1882		[b] 140	$160	100,000	$19,100	$19,260
1883		[b] 1,340	1,487	962,468	158,807	160,294
1888		[b] 320	301	232,819	39,114	39,415
1889		[b] 140	132	100,000	13,500	13,632
1882–1889	[c] 4,651	[b] 1,940	2,080	1,395,287	230,521	232,601
1907–1909, 1911–12	[d] 539	[e] 342	188	172,875	23,127	23,315
1913	[d] 964	831	502	385,239	59,712	60,214
Total	6,154	5,113	2,770	1,953,401	313,360	316,130

[a] For basis of figures, see Kirchhoff, C., jr., The copper industry of the United States: U. S. Geol. Survey Mineral Resources for 1881–82, pp. 216, 229, 1883; idem for 1883–84, p. 329, 1885. Knight, W. C., The Hartville district: Wyoming Univ. Agr. Coll. Dept. Bull. 14, pp. 135–136, October, 1893.

[b] Estimated by Charles W. Henderson on Mr. Kirchhoff's statement that ore contained ½ to ¾ ounce of silver for every per cent of copper.

[c] Estimated on basis of 15 per cent copper per ton (Kirchhoff).

[d] Mineral Resources records, collected from the mines.

[e] Mineral Resources records 1911–12. Estimated on 1911–12 record for 1907, 1908, 1909.

UINTA COUNTY.[4]

There was no production in Uinta County in 1913.

[1] See Hewett, D. F., The ore deposits of Kirwin, Wyo.; U. S. Geol. Survey Bull. 540, pp. 121–132, 1914.

[2] Laramie County prior to 1913.

[3] Smith, W. S. T., U. S. Geol. Survey, Geol. Atlas, Hartville folio (No. 91), 1903. Ball, S. H., Copper deposits of the Hartville uplift, Wyo.: U. S. Geol. Survey Bull. 315, pp. 93–107, 1907.

[4] Schultz, A. R., Gold developments in central Uinta County, Wyo., and at other points on Snake River: U. S. Geol. Survey Bull. 315, pp. 71–88, 1907.

MANGANESE AND MANGANIFEROUS ORES.

By D. F Hewett

INTRODUCTION.

For the year 1913 the production of manganese ore in the United States was 4,048 long tons, a notable increase over the output of 1912 and the largest production since 1908. This increase was due largely, however, to the activity of one mine which is now idle and can not, therefore, be depended upon as a continuous source of supply. No important new sources were discovered, though several deposits have been continuously developed and may become important sources during 1914.

Though exact figures are not yet available, the production both in India and in the Caucasus region appears to have been considerably greater than in 1912. An unofficial statement of exports from Russian ports shows an increase from 957,800 tons in 1912 to 1,100,000 tons in 1913.[1] This increase was accomplished in spite of strikes at the mines at Tchiaturi and at the port of Poti during the months of June and July, 1913.

In the United States, probably owing to the increase in production of ores in foreign countries, the price of ferromanganese declined steadily from the high figures reached in 1912.

SOURCES OF MANGANESE.

Manganese minerals.—For commercial purposes materials containing manganese are separated into four classes: (1) Manganese ores, (2) manganiferous iron ores, (3) manganiferous silver ores, and (4) manganiferous zinc residuum. This classification is based on the character of the materials now available in the United States and is due largely to the nature of the deposits, and as it is purely commercial it may be incomplete if applied to resources in foreign countries, or it may contain superfluous classes. Thus the United States alone possess large deposits of franklinite, which when roasted yields manganiferous zinc residuum. Though manganese forms a part of about a hundred minerals and is a relatively widespread element, practically all the manganese of commerce is derived from material containing one or more of the first seven of the minerals named in the following table.[2]

[1] Staff correspondence Min. Jour., London, Jan. 3, 1914.

[2] For details concerning manganese minerals the reader is referred to a recent exceptionally complete and valuable work by L. Leigh Fermor (The manganese deposits of India: Geol. Survey India Mem., vol. 37, pt. 1, pp. 1–209, 1909).

Bulletin 427 of the United States Geological Survey (Manganese deposits of the United States, by E. C. Harder, 1910) contains brief descriptions of most of the known deposits of the United States, as well as the imporant deposits of the world, and concise summaries of the chemistry and mineralogy of manganese.

Principal manganese minerals.

Mineral.	Composition.	Percentage of manganese.
Polianite	MnO_2	63.2
Pyrolusite	$MnO_2.n\ H_2O$	60–63
Psilomelane	$MnO_2.(MnKBa)O.n\ H_2O$	45–60
Wad	Hydrous impure mixture of manganese oxides	5–50
Manganite	$Mn_2O_3.H_2O$	62.4
Braunite	$3Mn_2O_3.MnO.SiO_2$	69
Franklinite	$(FeZnMn)O.(FeMn)_2O_3$	10–19
Rhodochrosite	$MnO.CO_2$	47.56
Rhodonite (manganese pyroxene)	$MnO.SiO_2$	41.9
Tephroite (manganese olivine)	$2MnO.SiO_2$	54.3
Spessartite (manganese garnet)	$3MnO.Al_2O_3.3SiO_2$	33.3

Manganese ores.—Commercial manganese ores are those which contain at least 35 per cent manganese and otherwise conform to the specifications of the trade in which they are used. Deposits of manganese ore [1] occur in many parts of the United States, but are most abundant in the Appalachian and Piedmont regions, in the southern Mississippi Valley, and on the Pacific coast. Small deposits occur in the New England, Rocky Mountain, and Great Basin regions. The principal producing districts up to the present time have been the James River-Staunton River and the Blue Ridge regions in Virginia, the Cave Springs and the Cartersville districts in Georgia, the Batesville district in Arkansas, and the Livermore-Tesla districts in California. Districts of minor importance are the New River region in Virginia, the northeastern Tennessee region, the McCormick region in South Carolina, and the Little Grande district in Utah. Mining and shipping in Virginia is now confined to the Blue Ridge and the James River-Staunton River regions.

Manganiferous iron ores.—Manganiferous iron ores consist of mixtures of manganese and iron oxides and hydrous oxides, which though usually containing manganese in excess of 5 per cent, may contain as little as 1 per cent. The proportion of iron in such ores is highly variable, but usually exceeds 40 per cent. Manganiferous iron ores occur in the United States chiefly in the New England, the Appalachian, and the Lake Superior regions, and minor deposits are found in the southern Mississippi Valley and in the Rocky Mountain region. High-grade manganiferous iron ore used for its manganese content occurs in the Appalachian region. Other manganiferous iron ores, which are so low in manganese that they are classed as iron ores, are produced in the Appalachian and the Lake Superior districts. In the blast furnace they yield a "high-manganese" pig iron, which is used for special purposes.

Manganiferous silver ores.—Manganiferous silver ores consist of mixtures of manganese and iron oxides and hydrous oxides, with small quantities of silver and lead minerals. As a rule the iron content exceeds the manganese content, but locally the iron is altogether absent.

Manganiferous silver ores are divided, according to their uses, into three classes:

[1] For greater detail refer to Harder, E. C., Manganese deposits of the United States: U. S. Geol. Survey Bull. 427, 1910.

1. The greater part of the manganiferous silver ores mined are used for their silver and lead content. Their content of manganese and iron insures many of these ores a higher price because of their fluxing value.

2. Some manganiferous silver ore is too low in silver and lead to be used as a source of these metals, but is sufficiently high in manganese and iron to be used for the manufacture of ferromanganese and spiegeleisen, a use that is made also of the high-grade manganiferous iron ores already mentioned.

3. A third class of manganiferous silver ore is too low in silver and lead to be used primarily for their content of these metals and too low in iron and manganese to be used for the manufacture of iron-manganese alloys. This ore is sold to the smelters as flux, the iron and manganese becoming waste products, and the silver and lead content being recovered during the smelting.

Manganiferous silver ores occur in the Rocky Mountain and Great Basin regions, the principal producing locality being Leadville, Colo. Leadville ores have been used in making spiegeleisen from time to time, but none are now used for this purpose.

Manganiferous zinc residuum.—Manganiferous zinc residuum is an artificial furnace product consisting of manganese and iron oxides in a matrix of slag. Manganiferous zinc residuum is obtained from zinc volatilizing and oxidizing furnaces using New Jersey zinc ores. The residuum consists largely of iron and manganese oxides, the zinc having been removed by volatilization and collected as zinc oxide. The crude ores contain franklinite, zincite, and willemite and are obtained only from the Franklin Furnace district, New Jersey. Small quantities of zinc residuum are used annually in the manufacture of spiegeleisen.

MANGANESE ORE.

PRODUCTION IN THE UNITED STATES.

The following table shows the quantity, value, and average price per ton of the manganese ore produced and marketed in the several States for 1911, 1912, and 1913:

Marketed production of manganese ore in the United States, 1911–1913, by States, in long tons.

State.	1911			1912			1913		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
California	(a)	(a)	.....	(a)	(a)	.....	.....	.....	.....
South Carolina	.....	.....	.....	(a)	(a)	.....	.....	.....	.....
Virginia	[b]2,457	[b]$24,586	$10.01	[c]d1,664	[c]$15,723	$9.45	[d]4,048	[d]$40,480	$10.00
Total	2,457	24,586	10.01	1,664	15,723	9.45	4,048	40,480	10.00

[a] Included with Virginia.
[b] Includes production of California.
[c] Includes production of California and South Carolina.
[d] Includes small tonnage produced in 1911 and 1912, but not reported for those years.

Virginia is the only State from which a production of manganese ore during 1913 was reported. As far as reports from owners have been received, development work was carried on at one deposit in Washington and at several in Virginia.

Development work was carried on by the Rockbridge Manganese & Iron Co., at Midvale, Va.; the Pittsburgh Manganese Co., at Elkton, Va.; and the Seibel Iron Mines Co., Happy Creek, Warren County, Va. The Piedmont Manganese Co., which for two years has operated mines near Six Mile Bridge, ceased all work in December, 1913.

The following table shows the total production of manganese ore in the United States, by States, as compiled from previous volumes of Mineral Resources. The figures showing the production prior to 1880 are only approximate; those for the years since 1910 represent the marketed production, based upon reports from the individual producers. Virginia, Georgia, and Arkansas have produced 94 per cent of the total, but for 10 years the production of the latter two States has been negligible.

Production of manganese ore in the United States, 1838–1913, in long tons.

Year.	Alabama.	Arkansas.	California.	Georgia.	Indian Territory, Michigan, Missouri, Montana, and Nevada.	North Carolina.	Pennsylvania, South Carolina, and South Dakota.	Tennessee.	Utah and Vermont.	Virginia.	West Virginia and other States.	Total.
1838–1879		410										410
1866–1879				19,950								19,950
1867–1879			5,500							18,000		23,500
1880				1,800						3,661	300	5,761
1881		100		1,200						3,295	300	4,895
1882		175		1,000						2,982	375	4,532
1883		400								5,355	[a] 400	6,155
1884		800								8,980	[a] 400	10,180
1885		1,483	200	2,580	(Nev.) 200					18,745	50	23,258
1886	75	3,316	100	6,041	(Nev.) 30	14		50		20,567		30,193
1887		5,651		9,024		14				19,835		34,524
1888		4,312	1,500	5,568	(Mich.) 100		(Pa.) 22			17,646	[b] 50	29,198
1889		2,528	53	5,208	(Nev.) 15	47	(S. C.) 124	30	(Vt.) 1,576	14,616		24,197
1890		5,339	386	749	(Nev.) 100	14				12,699		19,287
1891		1,650	705	3,575	(Ind. T.) 206		(S. Dak.) 19		(Vt.) 49	16,248		22,452
1892		6,708		826						6,079		13,613
1893		2,020	400	724				482		4,092		7,718
1894		1,934	278	1,277				922		1,797	(W. Va.) 100	6,308
1895		2,991	525	3,856			(Pa.) 460			1,715		9,547
1896		3,421	284	4,085		2	(Pa.) 265			2,018	(W. Va.) 13	10,088
1897		3,240	484	3,332	(Mich.) 37		(Pa.) 354	11		3,650		11,108
1898	22	2,662	541	6,689				381		5,662		15,957
1899		356	115	3,089	(Mo.) 16	90	(Pa.) 12	19		6,228	(W. Va.) 10	9,935
1900		145	131	3,447	(Mont.) 137			30		7,881		11,771
1901	17	91	610	4,074	(Mo.) 28			400	(Utah) 2,500	4,275		11,995
1902		82	846	3,500			(S. C.) 8			3,041		7,477
1903			16	500			(S. C.) 25		(Utah) 483	1,801		2,825
1904			60						(Utah) 32	3,054		3,146
1905			1	150				20		3,947		4,118
1906		62	1					30	(Utah) 800	6,028		6,921
1907			100				(S. C.) 800	100		4,604		5,604
1908										6,144		6,144
1909			[c]					[c]		[d] 1,544		1,544
1910 [f]		[c]								[e] 2,258		2,258
1911 [f]			[c]							[g] 2,457		2,457
1912 [f]			[c]				(S. C.) [c]			[h] 1,664		1,664
1913 [f]										4,048		4,048
Total	114	49,876	12,836	92,244	869	181	2,089	2,475	5,440	246,616	1,998	414,738

[a] Georgia and North Carolina.
[b] Nevada, North Carolina, South Carolina, Tennessee, and Vermont.
[c] Included with Virginia.
[d] Includes production of California and Tennessee.
[e] Includes production of Arkansas.
[f] Marketed production.
[g] Includes production of California.
[h] Includes production of California and South Carolina.

STOCKS.

The following table shows the quantities of mined manganese ore on hand at the mines at the close of 1911, 1912, and 1913:

Stock of manganese ore on hand at the mines Dec. 31, 1911, 1912, and 1913, by States, in long tons.

State.	1911	1912	1913
Arkansas			25
California	102	105	105
Virginia	1,405	410	1,855
Total	1,507	515	1,985

IMPORTS.

The following tables, compiled by the Bureau of Foreign and Domestic Commerce, Department of Commerce, show the imports of manganese ore into the United States from different countries and by ports of entry for 1911, 1912, and 1913:

Imports of manganese ores into the United States, calendar years 1911–1913, by countries, in long tons.

Country.	1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Brazil	41,600	$342,769	81,580	$510,300	70,200	$445,680
Russia	19,103	186,590	83,354	490,306	124,337	712,324
British India	106,580	501,746	128,645	644,162	141,587	710,024
Cuba						
France	4,043	51,648	2,021	25,071	1,114	12,578
Netherlands	114	1,992				
Japan					3	78
Germany	3,941	76,940	3,245	70,644	2,014	103,612
United Kingdom	600	12,810	752	14,069	227	12,082
Canada	32	745	55	2,021	5	631
Belgium	837	11,401	2	26		
All other countries	2	150	1,027	12,555	5,603	32,671
Total	176,852	1,186,791	300,661	1,769,184	345,090	2,029,680

Manganese ores imported into the United States, calendar years 1911–1913, by customs districts, in long tons.

Customs district.	1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Philadelphia, Pa.	72,581	$431,455	143,537	$788,243	167,418	$916,395
Baltimore, Md.	99,008	658,421	153,039	900,273	170,056	961,622
New York, N. Y.	3,830	69,260	3,345	65,036	1,222	88,949
Boston, Mass.	5	259	8	235	77	3,129
New Orleans, La.			110	670	370	2,375
All other	1,428	27,396	622	14,727	5,947	57,210
Total	176,852	1,186,791	300,661	1,769,184	345,090	2,029,680

Imports of manganese ore increased approximately 15 per cent from 1912 to 1913, and this increase came almost wholly from Russia. Unless industrial or political disturbances interfere, there is no doubt that a supply of ores will be available from the deposits of Russia, India, and Brazil for some years to come.

The total quantity of manganese ore imported into the United States, as far as has been recorded, is shown in the following table.

The figures for the years 1868 to 1888 represent imports from Canada only; those from 1889 to the present time represent total imports.

Imports of manganese ore into the United States, 1868–1913, in long tons.

Year ending—	Quantity.	Year ending—	Quantity.	Year ending—	Quantity.
June 30—		Dec. 31—Contd.		Dec. 31—Contd.	
1868	1,017	1883	1,326	1900	256,252
1869	488	1884	603	1901	165,722
1870	1,402	1885	1,684	1902	235,576
1871	1,050	1886	1,818	1903	146,056
1872	1,206	1887	1,630	1904	108,519
1873	838	1888	1,182	1905	257,033
Dec. 31—		1889 [a]	4,286	1906	221,260
1873	1,031	1890	34,154	1907	209,021
1874	782	1891	28,825	1908	178,203
1875	203	1892	58,572	1909	212,765
1876	412	1893	68,113	1910	242,348
1877	891	1894	44,655	1911	176,852
1878	626	1895	86,111	1912	300,661
1879	1,886	1896	31,489	1913	345,090
1880	2,179	1897	119,961		
1881	1,704	1898	114,885	Total	[b] 3,859,616
1882	894	1899	188,349		

[a] Figures prior to 1889 represent imports from Canada only, total importations from other countries for these years not being obtainable.
[b] This total duplicates the importation from Jan. 1 to June 30, 1873.

PRODUCTION IN PRINCIPAL PRODUCING COUNTRIES.

The following table gives the latest available statistics with regard to American and foreign production of manganese ore.

Figures for all foreign countries except Canada, Belgium, France, German Empire, Italy, and Spain are taken from Mines and Quarries, London. For these countries the figures are taken from the official statistical reports published by the several Governments.

Production of manganese ore in principal producing countries, 1909–1912, in long tons.

Country.	1909	1910	1911	1912
North America:				
Canada	.....	.....	5	67
Nova Scotia	[a]	22	134	[a]
United States	1,544	2,258	2,457	1,664
South America:				
Brazil [b]	236,982	249,954	171,172	[a]
Europe:				
Austria	17,761	15,447	15,703	[a]
Bosnia and Herzegovina	5,602	3,937	3,543	[a]
France	9,252	7,874	5,906	[a]
German Empire	75,962	79,291	85,921	[a]
Greece	5,289	40	721	[a]
Hungary	11,733	13,061	14,523	[a]
Italy	4,626	4,134	3,460	2,599
Russia	588,456	[c] 394,405	[c] 572,028	[a]
Spain	7,703	8,471	5,519	[a]
Sweden	5,189	5,719	5,347	[a]
Turkey	[d] 7,459	[e] 12,008	[a]	[a]
United Kingdom	2,768	5,467	4,987	4,170
Asia:				
India	642,675	800,907	670,290	[a]
Japan	8,708	11,121	9,615	[a]
Portuguese India	[f]	[e]	[e]	[a]
Africa:				
Cape Colony	.....	[g]	[b] 116	[a]
Natal	.....	51	.....	[a]
Oceania:				
Australia	603	815	1,151	[a]
New Zealand	6	5	[h]	[a]

[a] Statistics not yet available.
[b] Exports.
[c] Exported from Batum and Poti.
[d] Exported from Stratoni.
[e] Year ending Mar., 1909.
[f] Quantity not stated; value of production, $19.
[g] Quantity not stated. Exports valued at $18,609 in 1910 and at $13,266 in 1911.
[h] Quantity not stated. Exports valued at $7,786.

MANGANIFEROUS ORES.

Manganiferous ores are of two classes: (1) Those which contain iron greatly in excess of manganese and which are smelted direct to a manganiferous cast iron containing 1 to 4 per cent manganese, or those in which manganese equals or is in excess of the iron and which with other iron ores is smelted to a similar product; and (2) those which are used for fluxing, the manganese oxides forming a more fluid slag. Of the first class are ores of the Lake Superior region, Arkansas, and Virginia. So far as can be ascertained, the manganiferous ores of Colorado are the only ores used for fluxing, and the smaller demand for these ores is due to the fact that the smelting of iron ores is of minor importance compared to the smelting of lead and copper ores containing gold and silver, in which industry refractory mixtures frequently require the use of manganiferous iron ores to aid in fluxing. Up to 1909 a part of the Colorado ores was used in the manufacture of spiegeleisen.

For use as a flux the value of manganiferous iron ore, like that of many ores which contain both precious and base metals, depends on several factors, among the more important of which are: (1) Combined manganese and iron content, (2) content of silica, (3) content of precious metals, (4) the deductions and adjustments of these factors, based on the temporary demands of the smelter that buys such ores. The ores produced in the Leadville district, Colorado, for 1912, range in composition as follows: Manganese, 2 to 37 per cent; iron, 8 to 50 per cent; siliceous material (insoluble), 5 to 34 per cent; silver, trace to 14 ounces per ton; gold, trace; lead, trace to 5 per cent. The average composition of the entire product is manganese, 12 per cent; iron, about 33 per cent; siliceous material, about 10 per cent; silver, 5.5 ounces; gold, trace; lead, 1.5 per cent.

For such ores smelters pay at the rate of 15 cents per unit (or per cent) for the excess over 40 per cent of the combined iron and manganese content after deducting the silica or siliceous material, and for silver 95 per cent of the content at New York quotations. The deduction of 40 per cent from the combined iron-manganese content is made in lieu of a charge for smelting. By this method of calculating, the value of the Leadville ores, exclusive of that of the precious metals, ranges from nothing to $1.50 per ton, and the average value of the total production is 12 cents per ton. If the value of the silver content be added to this, the total is $3.15 per ton.

Prior to 1912, it was possible to state only the total value of these ores, as but a single figure, the gross value, has been reported by producers. More complete data are now available and the present method of calculation is more closely in accord with that adopted by the Survey.

The most important feature of the year in the Lake Superior region with regard to the manganiferous iron ore market was the appearance of 2 new companies in the Cuyuna range in the list of producers. The increase in production in Arkansas was due to the activity of one company:

The following table shows the production of Arkansas and Colorado for 1910, 1911, 1912, and 1913, and the average price per ton:

Marketed production of manganiferous ores used principally for fluxing or other purposes in Colorado and Arkansas, 1910–1913, in long tons.

Year.	State.	Percentage of manganese.	Quantity.	Value.	Average price per ton.[a]
1910	Arkansas	20–25	5,030	$9,700	$1.93
	Colorado	5–26	55,770	176,448	3.16
1911	Arkansas	20	2,177	4,354	2.00
	Colorado	4–40	41,753	109,340	2.62
1912	Arkansas	20	1,332	2,997	2.25
	Colorado	6–24	48,618	12,646	.23
1913	Arkansas	16–25	9,650	19,250	1.99
	Colorado	2–37	49,753	5,874	.12
Total			214,083	340,609	1.59

[a] For excess manganese and iron only, and excluding value of precious metals in Colorado ores.

The production of manganiferous ores in the United States from 1885 to 1912 is shown in the following table:

Production of manganiferous ores in the United States, 1885–1913, in long tons.

Year.	Arkansas.	Colorado.[a]	Colorado.[b]	Lake Superior region.	Virginia.	Other States.	Total.
1885						(Mont.)[b] 4,263	4,263
1886			[c]60,000	257,000			317,000
1887			[c]60,000	210,000	1,025	[d] 726	271,751
1888			[c]60,000	201,036		[e] 1,096	262,132
1889			64,987	81,359			146,346
1890		6,397	51,840	61,863			120,100
1891		964	79,511	132,511			212,986
1892		2,942	62,309	147,431	3,000		215,682
1893	160	5,766	55,962	110,648	1,188	(N. C.) 20	173,744
1894		7,022	31,687	198,466			237,175
1895		13,464	54,163	112,265			179,892
1896		9,072	138,079	329,640			476,791
1897		16,519	149,502	184,585		(Vt.) 1,200	351,806
1898		18,848	99,651	268,862		(Pa.) 100	387,461
1899		29,355	79,855	732,490			841,700
1900		43,303	188,509	334,274			566,086
1901		62,385	228,187	512,084		(N. C.) 20	802,676
1902		13,275	194,132	884,939	3,000		1,095,346
1903		14,856	179,205	566,835	2,802		763,698
1904	600	17,074	105,278	365,572			488,524
1905	3,321	45,837	81,738	720,098			850,994
1906	8,900	32,400	(*f*)	[g] 1,000,000			1,041,300
1907	4,133	67,514	32,197	314,316		(N. M.) 7,000	425,160
1908	4,066	15,973	35,581	467,140	274		523,034
1909	3,325	12,905	52,119	775,035	305		843,689
1910	5,030		55,770	558,634	301		619,735
1911	2,177		41,753	477,920	507		522,357
1912	1,332		48,618	816,984	1,567		868,501
1913	9,650		49,753	612,743			672,146
Total	42,694	435,871	2,340,386	11,434,730	13,969	14,425	14,282,075

[a] Manganiferous silver ore used in the manufacture of spiegeleisen and ferromanganese.
[b] Manganiferous silver ore used for flux; mainly from Colorado, but in a few cases probably including other Western States.
[c] Contains some Montana ore.
[d] Georgia 195 tons, Maine 50 tons, and Vermont 481 tons.
[e] North Carolina, South Carolina, and Tennessee 96 tons, and Vermont 1,000 tons.
[f] Not recorded.
[g] Estimated.

MANGANIFEROUS ZINC RESIDUUM.

Unique deposits of zinc ore containing franklinite, willemite, zincite, calcite, and minor silicate and other minerals occur near Franklin Furnace, N. J. By mechanical and electromagnetic processes of separation, three products are obtained from these ores, one containing the greater proportion of the franklinite and the remaining two the other zinc minerals. The franklinite product is first roasted with anthracite to eliminate the zinc, which is recovered as zinc oxide, and the residue, containing 12 per cent manganese and 40 per cent iron, is smelted to spiegeleisen.

The production of manganiferous residuum was approximately the same in 1913 as in 1912. The price given for this material, as stated elsewhere, is arbitrary, as it is not sold in the open market but reduced to spiegeleisen by the company that produces it. The production, value, and price per ton from 1905 to 1913 are given in the following table:

Production of manganiferous zinc residuum in the United States, 1905–1913, in long tons.

Year.	Quantity.	Value.	Average price per ton.
1905	90,289	$90,289	$1.00
1906	93,461	93,461	1.00
1907	93,413	280,239	3.00
1908	110,225	330,675	3.00
1909	141,264	423,792	3.00
1910	137,173	411,519	3.00
1911	109,296	291,344	2.67
1912	104,670	314,010	3.00
1913	102,239	306,717	3.00
Total	982,030	2,542,046	2.59

The following table shows the production of manganiferous zinc residuum from 1889 to 1912:

Production of manganiferous residuum from zinc roasting in the United States, 1889–1913, in long tons.[a]

1889	43,648	1898	48,502	1907	93,413
1890	48,560	1899	65,010	1908	110,225
1891	38,228	1900	87,110	1909	141,264
1892	31,859	1901	52,311	1910	137,173
1893	37,512	1902	65,246	1911	109,296
1894	26,981	1903	73,264	1912	104,670
1895	43,249	1904	68,189	1913	102,239
1896	44,953	1905	90,289		
1897	33,924	1906	93,461	Total	1,790,576

[a] The manufacture of spiegeleisen from manganiferous residuum was begun in 1870, but there is no record of the tonnage of raw material used prior to 1889.

FERROMANGANESE AND SPIEGELEISEN.

PRODUCTION.

The marketed production of ferromanganese and spiegeleisen was approximately the same in 1913 as in 1912. Both spiegeleisen and ferromanganese were produced in Pennsylvania and Illinois during the year. Spiegeleisen was reported from Colorado also in 1913.

Production of spiegeleisen and ferromanganese in the United States, 1872–1913, in long tons.

1872	4,072	1887	42,498	1902	212,934
1873	3,930	1888	48,901	1903	192,661
1874	4,070	1889	76,628	1904	219,446
1875	6,993	1890	133,180	1905	289,983
1876	5,907	1891	127,766	1906	300,500
1877	7,897	1892	179,131	1907	339,348
1878	9,530	1893	81,118	1908	152,018
1879	12,438	1894	120,180	1909	225,040
1880	17,503	1895	171,724	1910	226,216
1881	18,827	1896	131,940	1911 [a]	178,615
1882	19,610	1897	173,695	1912 [a]	227,939
1883	21,941	1898	213,769	1913 [a]	226,475
1884	30,262	1899	219,768		
1885	30,956	1900	255,977	Total	5,295,688
1886	42,841	1901	291,461		

[a] Marketed production. Figures collected by United States Geological Survey.

The content of manganese in spiegeleisen and ferromanganese varies slightly according to the source of the ores, and the method of manufacture and the prices of the alloys depend on the percentage of manganese.

The following table shows the range in prices for the iron-manganese alloys for 1913:

Prices per long ton for iron-manganese alloys during 1913.

Alloy.	1913				
	Percentage of manganese and silicon.	January.	Maximum.	Minimum.	December.
Ferromanganese [a]	75–80 Mn	66.95	76.95	49.46	49.46
Spiegeleisen [a]	15–20 Mn	26.90	26.90	25.00	25.00
Silicospiegel [a]	15–20 Mn, 10–12 Si	26.90	27.90	25.00	25.00

[a] Compiled from weekly reports published in the Industrial World, of Pittsburgh.

IMPORTS.

The imports of ferromanganese for 1913 were the greatest on record, whereas the imports of spiegeleisen have declined to a negligible quantity. With the development of new foreign supplies of ore, there are rumors from time to time that efforts will be made to manufacture ferromanganese at the mines, notably in Russia, Australia, and India, but there is little assurance that this will be done in the near future.

The following table, compiled from data furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce, shows the quantity and value of the imports for consumption of ferromanganese and spiegeleisen from 1903 to 1913:

Ferromanganese and spiegeleisen imported and entered for consumption, 1903–1913, in long tons.

Year.	Ferromanganese.		Spiegeleisen.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	41,519	$1,699,666	122,015	$2,709,317	163,534	$4,408,983
1904	21,813	707,057	4,623	132,461	26,436	839,498
1905	52,841	1,884,651	55,457	1,336,104	108,298	3,220,755
1906	84,359	4,953,644	103,268	2,942,940	187,627	7,896,584
1907	87,400	5,354,656	48,994	1,399,381	136,394	6,754,037
1908	44,624	1,860,664	4,579	125,054	49,203	1,985,718
1909	88,934	3,396,381	16,921	356,447	105,855	3,752,828
1910	114,228	4,341,071	25,383	489,049	139,611	4,830,120
1911	80,263	3,015,062	20,970	405,444	101,233	3,420,506
1912	99,137	3,906,920	1,015	28,094	100,152	3,935,014
1913	128,070	5,682,915	77	2,173	128,147	5,685,088
Total	843,188	36,802,667	403,302	9,926,464	1,246,490	46,729,131

USES OF MANGANESE.

The following list shows the composition and uses of some manganese alloys and minerals:

Manganese metals and minerals.[1]

1. Alloys:
   - Ferromanganese (alloy of manganese and iron).
   - Spiegeleisen (alloy of manganese and iron).
   - Manganese steel (alloy of manganese and iron).
   - Silicospiegel (alloy of manganese, iron, and silicon).
   - Manganese bronze (alloy of manganese and copper).
   - Silver bronze (alloy of manganese, aluminum, zinc, and copper).
   - Alloys of manganese with aluminum, zinc, and tin.
2. Oxidizers:
   - Decolorizer of glass.
   - Dry batteries.
   - Leclanche's cell.
   - Drier of varnishes and paints.
   - Preparation of oxygen on a small scale.
   - Manufacture of disinfectants (manganese and permanganates).
3. Coloring materials:
   - Coloring glass, pottery, tiles, and bricks.
   - Calico printing and dyeing.
   - Paints (brown; green; violet).
4. Flux in smelting silver and lead ores.
5. Gems or ornamental stones, in the form of the minerals rhodonite and spessartite.
6. Fertilizer.
7. Various lesser chemical, manufacturing, and medical uses.

1. *Alloys.*—Three classes of ores—manganese ores, manganiferous iron ores, and manganiferous zinc residuum—are used directly or indirectly in the manufacture of iron and steel. Ore used in the manufacture of iron-manganese alloys should contain at least 40 per cent manganese and less than 0.20 per cent phosphorus. Silica and other impurities are easily eliminated in the operation of smelting, but most of the phosphorus in the ores remains and is present in the final product. For making nonferrous manganese alloys high-grade ores relatively low in iron are desired. Manganiferous iron ores are not now used in the manufacture of iron alloys of manganese, such as are used

[1] Adapted from table given by L. Leigh Fermor (Manganese deposits of India: Geol. Survey India, Mem., vol. 31, pt. 3, p. 581, 1909), which in turn was adapted from table presented by R. A. F. Penrose, Arkansas Geol. Survey Ann. Rept., vol. 1, p. 7, 1890.

in the steel industry, but are used for the direct production of manganiferous cast iron, which is used for making various kinds of castings, such as car wheels. It possesses some of the properties of manganese steel, notably resistance to abrasion.

Though manganese in the form of ferromanganese is added to practically all steel, whether produced by the Bessemer or the open-hearth process, the quantity present in the final product is not so large as greatly to affect its physical properties, at least not to the same extent as the carbon content. Manganese steel contains from 12 to 40 per cent manganese, and these proportions are essential to produce the peculiar properties possessed by these steels, which are hard, but, with proper heat treatment, not brittle, and malleable, though they offer great resistance to cutting tools. These properties make the manganese steels highly useful in the manufacture of two classes of articles: (1) Those which must offer great resistance to abrasion, either by friction against smooth, hard surfaces, or against hard, brittle, and angular materials; (2) those which must resist strains due to shock accompanying such abrasion. Articles now commonly made of manganese steel are: Gears, pinions, sprockets, chains, dies, liners, wearing plates, rolls and rollers, railroad frogs and switches, and the crushing faces and digging parts of crushing and pulverizing machinery, such as plates, dies, rollers, stamp-mill shoes. For making some of these articles manganese steel is practically the only alloy available, but for making others it is no more desirable than some other alloys, such as those of chromium, vanadium, and tungsten, with which it must compete at current prices.[1]

The nonferrous alloys of manganese have small use and the amount of manganese ores necessary to supply them is not important.

2. *Oxidizers.*—Manganese ore used as an oxidizer acts only as an agent for carrying oxygen, hence it is important that the ores employed for the purpose contain a large percentage of manganese dioxide, either in the form of the minerals pyrolusite (or polianite, which is rare), or other minerals that easily liberate oxygen.

The following table shows the proportion of manganese dioxide and available oxygen contained in the common manganese minerals:[2]

Manganese oxide and available oxygen in certain manganese minerals.

Mineral.	Manganese dioxide.	Available oxygen.
Pyrolusite (polianite)	100.00	18.39
Psilomelane	42.46–77.33	7.81–13.06
Manganite	49.44	9.09
Braunite	43.11	7.93
Hausmannite	37.99	6.99
Rhodochrosite	None.	None.

Among the industries using manganese ores as an oxidizer or source of oxygen, the manufacture of flint glass consumes the largest quantity. Practically all the ores used for this purpose are imported, the principal sources being the deposits in the southern Caucasus Mountains, Russia, and Thuringia, Germany. These ore usually contain

[1] An article by S. R. Stone (Manganese steel for machinery parts), stating in detail the uses to which manganese steel is applicable, was published in Iron Age, vol. 91, p. 141, 1913.

[2] Fermor, L. L., loc. cit.

at least 80 per cent manganese dioxide, and less than 1 per cent iron. The amount of ore consumed annually by the individual glass plants is small, ranging from 10 to 200 tons each, and for this reason the ore is purchased from importers, who guarantee the grade. From 5 to 12 pounds of manganese ore per ton of sand (equivalent to 2 to 5 pounds per ton of glass) is used, according to the amount of iron present. The present annual consumption of manganese ores for their oxygen content in the United States is estimated at 10,000 tons.

For making dry batteries high-grade pyrolusite containing at least 85 per cent manganese dioxide and less than 1 per cent iron is used. The source of supply for the United States is largely the deposits of the Caucasus Mountains, Russia.[1]

3. *Coloring materials.*—The manganese ores that are commonly used in coloring pottery, tiles, and bricks are the argillaceous varieties, which contain less than 40 per cent manganese and more siliceous material than is permitted in ores used in the manufacture of alloys. The quantity of manganese ores used in printing and dyeing is small. According to J. M. Hill,[2] the production of the manganiferous paint pigments, umber and sienna, during 1912 amounted to 805 tons, whereas 4,860,885 pounds (approximately 2,430 tons) of umber and 3,062,085 pounds (approximately 1,531 tons) of sienna were imported during the same year.

4. *Fluxes in smelting silver and lead ores.*—The manganese ores used as fluxes in smelting silver and lead ores are necessarily those which are relatively impure or which contain metals of greater value than the manganese. The ores are either too impure or the deposits are too far from steel works to be used in making ferro-alloys.

5. *Gems and ornamental stones.*—Rhodonite is a pink to rose-red mineral of hardness 6 (Mohs scale of hardness), which in places occurs in masses sufficiently large to permit its use as an ornamental stone. There is no present great demand for stone of this color in the United States, but should a demand arise it can probably be supplied from deposits in Maine, Massachusetts, Vermont, New Hampshire, Rhode Island, and Connecticut.[3]

6. *Fertilizer.*[4]—An elaborate series of experiments has recently been carried out by members of the Bureau of Soils, United States Department of Agriculture, with the view to determining the effect of a number of salts of manganese upon the growth of several grains and vegetables. Both pot and field tests were made and it is concluded that the crops in unproductive sandy loam soil are stimulated by the addition of 5 to 50 parts of manganese per million of soil, whereas no effects were noted when a productive loam soil was used. In some experiments an actual decrease in yield was attributed to the addition of manganese salts.

Other uses.—A review of the manganese-ore industry during recent years shows that though now, as heretofore, the greater part of the ores is consumed by the iron and steel industries, changes have been made in disposing of the remaining portion. Until recently most of the chlorine used in numerous chemical trades was made by the action of sulphuric acid on a mixture of manganese dioxide and salt, by which

[1] Richardson, H. K., The modern dry cell: Met. and Chem. Industry, vol. 10, p. 531, 1912.
[2] Hill, J. M., U. S. Geol. Survey Mineral Resources, 1912, pp. 965–966, 1913.
[3] Kunz, G. F., Gems and precious stones of North America, pp. 151–152, Scientific Publishing Co., 1890.
[4] Shirrer, J. J., and Sullivan, M. X., The action of manganese in soils: U. S. Dept. Agr. Bull. 42, 32 pp., 1914.

action 1½ pounds of dioxide were needed to produce 1 pound of chlorine. This process, however, has been displaced by that of producing chlorine by the electrical decomposition of salt (sodium chloride), either fused or in water solution, and as the chief object of the process is to produce sodium hydrate or other sodium salts, chlorine is a by-product, and more is produced than the trades can now consume.

The same may be said of the manufacture of oxygen. Much oxygen has heretofore been produced both for commercial and for experimental purposes by heating a mixture of manganese dioxide and potassium chlorate. Though this method is possibly still used in small laboratories, most commercial establishments now use oxygen prepared by the fractional distillation of liquid air or by the electrolysis of water. It is highly probable, however, that these losses in the uses of manganese ores have been more than compensated by the increased demand for it for use in dry batteries.

VALUE OF MANGANESE ORES.

The value of ores containing manganese depends on their mineralogical nature as well as their purity. The prices paid for ores of medium grade, for which the demand is greatest, are relatively stable, but the value of high-grade ores, which are consumed in much smaller quantities, fluctuates greatly.

The value of the ores used in the metallurgical industries varies with their content of metallic manganese and is governed largely by the specifications announced from time to time by the Carnegie Steel Co., Pittsburgh, Pa. The specifications now in use are given below:[1]

Schedule of prices paid per ton of 2,240 pounds for domestic manganese ore delivered at Pittsburgh or Bessemer, Pa., and South Chicago, Ill.

Prices are based on ores containing not more than 8 per cent silica or 0.20 per cent phosphorus and are subject to deductions as follows: For each 1 per cent in excess of 8 per cent silica there shall be deduction of 15 cents per ton; fractions in proportion. For each 0.02 per cent, or fraction thereof, in excess of 0.20 per cent phosphorus there shall be a deduction of 2 cents per unit of manganese per ton.

Ores containing less than 40 per cent manganese or more than 12 per cent silica or 0.225 per cent phosphorus are subject to acceptance or refusal at the buyer's option.

Settlements are based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken being deducted from the weight.

Percentage of metallic manganese in ore.	Price per unit of manganese, in cents.
Over 49	24
46 to 49	23
43 to 46	22
40 to 43	21

According to these specifications, the prices paid for the ores range from $7 to $12 a ton.

The value of an ore adapted to use as an oxidizer varies with its content of manganese dioxide, and, in contradistinction to those used in metallurgical industries, does not depend, except incidentally, on its content of manganese metal. It is usually specified that ore

[1] Circular issued by Carnegie Steel Co., February 14, 1914.

required for use as an oxidizer shall contain at least 80 per cent manganese dioxide and not more than 1 per cent iron. As far as can be ascertained, there appears to be no established schedule, such as exists in the steel industry, but brokers supply ore under guaranteed specifications in lots ranging from 5 to 100 tons. Prices usually range from $20 to $35 per ton, but some small lots which are exceptionally well adapted to special uses have been disposed of at $50 a ton.

As the manganese content of manganiferous iron ores and manganiferous silver ores is used only indirectly, the value of these ores depends on local conditions in the metallurgical industries which consume them.

One consumer of manganiferous iron ores states [1] that 15 cents per unit would be paid for material containing less than 20 per cent insoluble matter, and 10 cents per unit of manganese for material containing 20 to 35 per cent insoluble matter. The maximum prices for these grades of ores therefore would range from $3.50 to $6 per ton.

Manganiferous silver ores are of value principally for their content of iron, silver, or metals other than manganese, which only rarely adds more than $3 a ton to their value. The more impure ores, such as will serve for coloring glass and pottery, are sold at prices ranging from $2 to $6 a ton f. o. b. works. Producers supply the greater part of these ores directly to the trades, and prices are wholly subject to contract.

Manganiferous zinc residuum is not sold in the open market but is smelted to spiegeleisen by the companies that produce it.

NOTES ON DOMESTIC MANGANESE DEPOSITS.

General.—Viewed over a long period manganese-ore mining in the United States can hardly be said to have been a very profitable industry. The causes are probably numerous, some of the more common being failure to explore the deposits sufficiently in advance of installation of washing equipment, lack of familiarity with the common features of the deposits in general, and possibly lack of high degree of technical skill on the part of operators. It is scarcely to be hoped that all contingencies can be anticipated or all mistakes avoided in the future, but attention may be called at this point to the fact that exceptional skill is required to exploit successfully deposits of the types found in the United States. Attention may also be directed to the fact that in the exploitation of such manganese deposits as occur in the eastern United States one possible source of revenue has been wholly overloooked, that which might be obtained from the saving under favorable conditions of the manganiferous clay derived from the washing plants. This product, known in the paint trades as umber, had an average value during 1912, according to Hill,[2] of $27.30 per ton. Pennsylvania is the only State from which a production of this pigment was obtained in 1912, though 4,860,885 pounds were imported, against 1,610,000 pounds [3] produced in the United States. Good grades of umber have the following composition [4]:

[1] Personal communication to the writer, March, 1914.
[2] Hill, J. M., Mineral paints: U. S. Geol. Survey Mineral Resources, 1912, pt. 2, p. 965, 1913.
[3] Includes sienna also.
[4] Hurst, G. H., Painters' colours, oils, and varnishes, p. 241, London, 1906.

Water, 12 to 18 per cent; silica, 4 to 30 per cent; manganese dioxide, 7 to 12 per cent; alumina, 3 to 12 per cent; ferric oxide, 22 to 36 per cent. There is good reason for believing that several mines operating in the Eastern States can produce pigments of this character if a little care be taken to select proper material underground and if appropriate equipment for saving it is installed.

Utah.—Hill [1] describes as follows a deposit of manganiferous sandstone on the north slope of the La Sal Mountains, Utah:

> About a mile north of Mesa post office a tunnel starts in at the base of the cliffs of the upper mesa. On the dump there is some manganese ore which is a replacement of slightly calcareous sandstone. Pyrolusite has replaced the lime and coated the quartz grains. Some of the ore is nearly pure manganese oxide. The tunnel is caved, but it is said that there is 10 feet of material similar to that seen on the dump.

NOTES ON FOREIGN MANGANESE DEPOSITS.

Africa.—Manganese deposits have recently been noted [2] in the province of Katanga, Belgian Congo. The most important have been observed in the valleys of upper Fungwe River adjacent to the Biano plateau. The ores are high grade and occur in relatively large deposits on the border of masses of biotite granite and norite, which are intruded into muscovite granite. The manganese minerals are thought to have been derived by the weathering of the minerals of the norite. These deposits may prove to have commercial value.

Less important deposits have been found in the southern part of Katanga. In these deposits the manganese minerals are interbedded with sedimentary rocks and are locally obscured by a mantel of iron ores.

Australia.—Large deposits of high-grade manganese ores are reported [3] to have been developed 38 miles from the port of Colquhoun, Victoria, Australia, and preparations have been made to mine them.

Bulgaria.—H. K. Scott [4] has recently described two groups of deposits in Bulgaria. The more important are groups of thin lenses of wad in Tertiary clays in eastern Bulgaria, 2 miles from the Black Sea, and 7½ miles south of the port of Varna. They appear to be related in origin to the important deposits of Tchiaturi (Caucasus). Minor deposits containing lenses of pyrolusite at the contact of andesite and limestone were noted 2 miles west of Jamboli.

Canada.—H. E. Kramm [5] describes recent development of some small deposits of manganese ore 10 miles north of New Ross, Nova Scotia. Manganese minerals associated with ocher form veinlike deposits in granite. Exploitation to a depth of 160 feet has shown four distinct zones—a surface zone of hydrous and anhydrous iron oxides with small amounts of manganese minerals; a second zone in which pyrolusite and manganite occur in ocherous clay, the proportion of the latter mineral increasing downward; a third zone in which psilomelane and manganite predominate, though pyrolusite is present; and a fourth zone in which psilomelane is the most important

[1] Hill J. M., Notes on the northern La Sal Mountains, Grand County, Utah: U. S. Geol. Survey Bull. 531, p. 117, 1913.
[2] Abstracted from Guillemain, C., On the knowledge of the ore deposits in the province of Katanga, Belgium Congo Colony: Zeitschr. prakt. Geologie, vol. 21, p. 333, 1913.
[3] Notes in Iron and Coal Trades Rev., London, vol. 87, p. 52, 1913.
[4] Notes on some Bulgarian mineral deposits: Inst. Min. and Met. Bull. 103, 1913.
[5] The occurrence of manganese at New Ross, Nova Scotia: Canadian Min. Jour., vol. 33, p. 660, 1913.

mineral. Young [1] notes the occurrence of quartz veins that contain pockets of manganese minerals in Ordovician slate on the south bank of Tetagouche River, New Brunswick.

Germany.—There has appeared recently an exceptionally complete summary of the German manganese and manganiferous iron ore industry.[2] The history of the industry; the character and output of each class of ore by mines and districts, 1907–1911; the name, location, and character of product of the metallurgical works using the ores; and finally a statement of imports and exports, 1900–1912, and of the prices of ores, 1907–1913, are all given in detail.

[1] Young, G. A., The Bathhurst district: Canada Geol. Survey Mem. 18, p. 77, 1911.
[2] Abstracted from Scheffer, The importance of manganese and manganiferous iron ores in German industry: Glückauf, vol. 49, pp. 2056–2062, 2111–2123, 2151–2165, 1913.

RECOVERY OF SECONDARY METALS.

By J. P. Dunlop.

INTRODUCTION.

"Secondary metals" are those recovered from scrap metal, sweepings, skimmings, drosses, etc., and are so called to distinguish them from the metals derived from ore, which are termed "primary metals." The distinction does not imply that secondary metals are of inferior quality. The reports to the Survey do not include the very large quantity of old iron and steel remelted, neither do they include the precious metals. In fact, while the data given in this statement cover a large field and form an essential addition to the reports on primary metals, the scope of the inquiry made by the Survey reveals only in a partial way the vast extent of the waste trade industry, which yearly becomes greater and better organized. The value of iron and steel reused probably exceeds that of remelted brass, and the value of the old rubber and paper stock utilized amounts annually to many millions of dollars. The Survey's inquiry was extended in 1913 to cover secondary aluminum, and the result appears to have justified the extra effort. The values given for the secondary metals are arbitrary and are based on the approximate average value of the primary metal for the year. While the junk dealer buys small and scattered quantities of scrap metals at low prices, which enable him to resell the material at a substantial profit regardless of the changing value of primary metal, the keen competition for large quantities of drosses and carefully sorted scrap metals results in good prices being paid for such waste materials. In fact, it appears that in 1913 the decline in metal prices and the slackened trade conditions, combined with sharp competition, raised comparative prices of scrap and drosses until the margin of the large jobbers, smelters, and refiners handling this material was too small to permit very profitable operation. Although the quantity of reclaimed metal compared favorably with that of former years, stocks of metal derived from scrap and drosses were much larger at the end of 1913 than in 1912. After remelting or refining, these secondary metals, selling at only slightly lower prices than new metal, displace an equivalent quantity of primary metals and must be considered in any estimate of stocks available for consumption in any year. For a few purposes requiring especial purity of material it is necessary to employ primary or virgin pig metal, but as a general rule secondary metals can be used in whole or in part. In fact most foundries, in order to compete for business successfully, must and do use secondary material, at least in part, and hence they purchase scrap metal and remelt it with primary pig metal or with composition ingot. The secondary

smelters by handling large quantities of all kinds of scrap are able to classify their material so as to produce continuously alloy metals of uniform composition suitable for use in work of different classes. Such composition ingots are being purchased and used in increasing quantities by many foundries and other manufacturers in place of primary metals or mixtures of new and scrap metals. It is asserted that the use of properly made and suitable composition ingot is more economical and produces better and more uniform products than the use of virgin metals or of mixed scrap and virgin metals in making alloys.

It has so far proved impossible to separate the statistics for secondary metal recovered from clean scrap made in the ordinary course of manufacture from the statistics of metal recovered from drosses and ashes and from scrap or old metal that had entered the trade as manufactured articles and been discarded. An estimate is given of the clean copper and brass scrap on the basis of replies from the larger secondary smelters and refiners, but no classification made by many of the dealers or smelters is available.

The use of magnetic separators to free scrap from iron, the recovery of metal from cinders and molding sand, and the use of machines to briquet small scrap in order to reduce the losses in melting continued to increase. Dealers and jobbers in scrap metal realize the necessity of combining to insure better grading of waste metals and of more efficient methods of packing in order to obtain lower shipping rates. The large smelters and refiners of waste metals and drosses, many of whom conduct a business amounting to millions of dollars yearly, recognize the importance of proper separation and grading of metal wastes and of selling alloys of guaranteed composition, but the smaller manufacturers and metal buyers have not been as careful as they might have been in view of the undoubted fact that the larger portion of all waste material is collected by junk men and jobbers, who resell the material to the smelters, refiners, or manufacturers. The use of old metals has extended rapidly, and any cooperation that will remedy trade objections to the use of secondary metals in any branch of manufacturing, as well as any saving that lowers the cost of treating waste products, must result in a broader market and prices more nearly approaching those for primary metal.

It is impracticable to segregate the statistics relating to the refining, remelting, and reuse of secondary metals according to States, but over 90 per cent of the refining and smelting of drosses and scrap metals in the United States is confined to the territory east of St. Louis and north of Ohio River. Reports were made by approximately 550 users of secondary material, of which about 150 were in Pennsylvania and West Virginia, 130 in New York, New Jersey, Connecticut, Maryland, and Massachusetts, and 150 in Ohio, Indiana, Illinois, and Michigan. Over 60 per cent of the secondary aluminum was reported from the States of Ohio, Illinois, and Michigan. Smelters and refiners in St. Louis, Chicago, Cincinnati, New York, and Philadelphia recovered over 80 per cent of the antimony in alloys. The larger portion of the secondary tin was refined by plants in Pennsylvania, New Jersey, and New York. The recoveries of lead, zinc, and copper were more generally distributed. The greater number of the larger smelters or refiners of secondary metals are located at or near New York, Philadelphia, Pittsburgh, Tottenville (N. Y.), Chicago, Cincinnati, St. Louis,

Detroit, and Cleveland, though there are many large plants at other places.

The value of the "secondary metals," exclusive of gold, silver, platinum, and iron, recovered in the United States in 1913, was $72,845,000, compared with $77,396,000 in 1912.

SECONDARY COPPER.

The total quantity of secondary copper recovered in 1913, on the assumption that the brass remelted had an average copper content of 70 per cent, was 136,500 tons, of which 18,661 tons (about 4,000 tons more than in 1912) was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by smelters of the latter class includes 36,716 tons of pig copper, 11,603 tons of copper in alloys other than brass, and 69,520 tons of copper in remelted brass. These figures indicate a decrease for 1913 of about 6,000 tons of pig copper and 1,500 tons of copper in brass and an increase of about 2,300 tons in alloys other than brass. At least 45,000 tons was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that only about 91,500 tons was obtained from ashes, cinders, and scrap, or from material that had actually been used and discarded. The value of the copper, both as metal and in alloys, is computed at the average yearly price quoted for casting copper by the American Metal Market. According to the Bureau of Foreign and Domestic Commerce, the exports of scrap brass fit only for remanufacture for the calendar year 1913 were 10,943 tons, and the imports were 3,395 tons. Many railways sell or turn in the larger portion of their brass and copper scrap and other metal waste to dealers in part payment for new material, but the reports received show that the railways utilized in their own shops and foundries over 12,670 tons of brass, in addition to 900 tons of copper and 2,828 tons of copper in alloys other than brass.

The production of copper from secondary sources in 1913 was equal to about 17 per cent of the refinery output of primary copper in the United States from all sources, or about 22.4 per cent of the primary copper smelted from domestic ore.

SECONDARY LEAD.

The secondary lead recovered in 1913 amounted to 72,834 tons or about 5,700 tons more than in 1912. The secondary lead recovered as pig lead increased about 2,800 tons, a normal increase in view of the fact that the average lead price was nearly the same in 1912 and 1913. The recovery of lead in alloys increased 2,900 tons compared with 1912. The increase of 2,800 tons of pig lead from secondary material was due wholly to the increased recoveries made by those regular smelters whose product is mainly primary metal. The increase reported to the Survey in the quantity of lead in alloys, much of which is derived from remelted babbitt and bearing metals, was doubtless due in part to a more careful canvass of the scrap-metal dealers, who not only act as brokers and middlemen but frequently remelt and sell babbitt, lead pipe, and spelter. Other important sources of secondary lead were old pipe, lead linings of acid tanks, and drosses from white-metal alloys. Regular smelters reported the

recovery of 9,328 tons of lead from lead and antimonial lead scrap. The total output of secondary lead was equal to 15.2 per cent of the refined lead produced in the United States in 1913, compared with 13.5 per cent in 1912, or to 16.7 per cent of the refined lead produced from domestic ores in 1913. It was exceeded by the domestic lead output of only two States—Missouri and Idaho—and only one other State—Utah—had an output of lead nearly as large as the secondary lead recoveries.

SECONDARY ZINC.

The output of secondary zinc (including that in brass) amounted to 79,570 tons and equaled 23 per cent of the production of primary spelter in the United States in 1913, compared with 24.1 per cent in 1912. The zinc recovered in alloys other than brass amounted to 3,743 tons, compared with 3,912 tons in 1912. Of the 50,005 tons of secondary zinc recovered as spelter, 25,991 tons were obtained by redistillation from drosses, skimmings, etc. In addition to the large quantity of spelter recovered, it is estimated that over 15,000 tons of zinc chloride were made from drosses and skimmings, and likewise several thousand tons of the zinc pigment lithopone.

The quantity of spelter recovered by redistilling drosses and skimmings was about the same in the years 1912 and 1913. Two zinc smelters in New Jersey and Pennsylvania which recover spelter entirely from drosses and skimmings used large 800-pound or 1,000-pound retorts instead of the small ones used by smelters treating ore or mixed ore and drosses. A large portion of the secondary spelter recovered was reported to be of high grade, ranging above 99 per cent pure and equaling in practically every respect the spelter made from ore. The quantity of secondary spelter produced by smelters having an output derived mainly from ores increased about 1,800 tons. This would apparently indicate that the practice of mixing zinc concentrates and drosses is extending. Although prices of spelter were much lower in 1913 than in 1912, the exports of zinc dross amounted to only 28 tons, compared with 205 tons in 1912 and 4,246 tons in 1911.

SECONDARY ANTIMONY.

The production of secondary antimony, of which all but 45 tons was recovered in alloys, increased from 2,506 short tons in 1912 to 2,705 tons in 1913. The value given is arbitrary and is based on the average yearly price for Cookson's antimony published by the American Metal Market. The only antimony ore of domestic origin smelted in the United States in 1913 was 116 tons from Nevada, which was mined prior to 1912. The regular smelters reported the recovery of 92 tons of antimony contained in antimonial lead scrap. The principal materials refined or remelted which contained antimony as an alloy were hard lead drosses, babbitt, solder, pewter, and type metal. The 1913 imports of antimony as metal in ore or as oxide amounted to 7,692 tons, and the recovery from secondary sources was equal to 35.1 per cent of the imports. The secondary recoveries of antimony were 500 tons more than the antimony content of antimonial lead or antimony ores of domestic origin smelted in 1913.

SECONDARY TIN.

Apparently there were no domestic tin ores smelted in the United States in 1913, though some tin concentrates were shipped from Nome, Alaska, Gaffney, S. C., and Spearfish, S. Dak., to Great Britain for treatment. This condition makes secondary tin an important factor in supplying domestic consumption. The secondary tin recovered in 1913 was equal to 27.2 per cent of the tin, as metal or as oxide, imported into the United States during the year (52,141 short tons). Secondary tin recoveries decreased from 15,401 tons, valued at $14,301,368, in 1912 to 14,178 tons, valued at $12,567,379, in 1913. The quantity recovered as tin was 6,415 tons and that in alloys and chemical compounds 7,763 tons. The value of the recovered tin here given is arbitrary and is based on the yearly average price given by the American Metal Market. It will be noted that the secondary tin in alloys increased about 700 tons, an increase similar to that of lead in alloys. The secondary pig tin decreased about 1,900 tons, for although the reports showed that the recoveries from scruff and drosses compared favorably with former years, the recoveries from clean tin scrap, tin foil, and tin pipe were appreciably less in 1913 than in 1912. This condition was natural, for the use of tin foil and block tin pipe has not expanded and the recoveries from those sources are relatively small. The quantity of clean tin scrap treated was considerably less in 1913 than it was in 1912. This was partly due to the burning of the Vulcan Detinning Co.'s electrolytic plant at Sewaren, N. J., and to decreased operations of several other users of clean scrap tin. There was no great incentive to treat tin scrap which had been contracted for or purchased at prices that precluded much profit at the prevailing lower prices of pig tin in 1913.

The recovered tin includes the tin content of products made by several plants from tin scrap. These included some tin oxide, putty powder, etc., but consisted mainly of tin chloride. The production of these compounds is calculated as metal and not separately stated, in order to avoid disclosing confidential information. As the products are made from scrap tin and thus conserve the primary metal, they are properly regarded as recovered tin. Two forms of tin chloride are handled commercially—stannic and stannous salts. Stannic chloride is usually sold either as a water solution, called bichloride of tin, or as an anhydrous sirupy liquid, termed tetrachloride of tin, and is used principally in the silk industry. Stannous chloride is sold in the form of crystals and is used in dyeing and calico printing.

Most of the tin oxide, tetrachloride, and other products were made from clean tin-plate clippings or from tin liquors left in dyeing or weighting silks. The dry chlorine process was used to recover the tin from the clippings in some places. In others reverberatory furnaces were used to remove the tin coating, and a large quantity of tin was recovered in the form of a tin powder by the electrolytic treatment of clean scrap, the powder being sent to secondary smelters. The largest recoveries of tin were made from the scruff and drosses that occur in making tin and terneplate and amounted to over 5,000 tons. Only one firm reported using old tin containers, from which the tin and solder were first sweated and the black plate remelted to make sash weights. Comparatively large quantities of tin scrap and old tin cans are used in the western mining regions for

the precipitation of copper from mine waters. Such scrap is plentiful, cheap, and fairly well adapted for the purpose. However, the tin coating of the scrap does not enter into the reaction and is lost entirely.

The principal alloys in which secondary tin was recovered were babbitt and other bearing metals, bronze, solder, pewter, and electrotype metal.

SECONDARY ALUMINUM.

For the first time the Survey obtained statements of the quantity of secondary aluminum recovered as pig aluminum or in alloys, and although the inquiry may not have reached all producers, the result shows that the percentage of secondary aluminum used compared with virgin metal was fully as large as in other nonferrous metals. The recoveries in 1913 amounted to 4,654 tons, valued at $2,199,480. Of the 4,654 tons the quantity recovered in alloys amounted to 2,456 tons, and over 90 per cent of this was an alloy of 92 per cent aluminum and 8 per cent copper, used for making sand castings. It is probable that a large part of the secondary pig aluminum was recovered from clean clippings and borings and that it also was utilized in making castings.

RECOVERY.

The following table shows the recovery of secondary metals in the United States in 1912 and 1913:

Recovery of secondary metals in the United States in 1912 and 1913, in short tons.

Metal.	1912		1913	
	Quantity.	Value.	Quantity.	Value.
Secondary copper, including that in alloys other than brass	66,441	$21,593,325	66,980	$20,536,068
Remelted brass	101,523	27,279,516	99,315	24,651,969
Secondary lead	30,266	6,045,120	33,104	6,409,392
Recovered lead in alloys	36,902		39,730	
Secondary spelter	52,251	7,750,494	50,005	6,019,776
Recovered zinc in alloys other than brass	3,912		3,743	
Secondary tin	8,333	14,301,368	6,415	12,567,379
Recovered tin in alloys	7,068		7,763	
Secondary antimony	13	426,020	45	460,932
Recovered antimony in alloys	2,493		2,660	
Secondary aluminum	.....	.....	2,198	2,199,480
Recovered aluminum in alloys	.....	.....	2,456	
Total	.....	77,395,843	.....	72,844,996

SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES IN 1913.

(MINES REPORT.)

By B. S. Butler and J. P. Dunlop.

INTRODUCTION.

By J. P. Dunlop.

The following is an account of the production of silver, copper, lead, and zinc in 1913 by the mines of the Central States, including Arkansas, Illinois, Kansas, Kentucky, Michigan, Missouri, Oklahoma, and Wisconsin. The territory thus embraced lies in the great interior valley province of the United States which extends from the Appalachian system to the Rocky Mountain front, excluding the Black Hills. Most of the mines are developed in the Paleozoic sedimentary rocks of this province, but the copper range of northern Michigan comprises lavas and intercalated sediments of pre-Cambrian age.

The statistics of production in this country have been compiled by the United States Geological Survey from confidential reports by each mine in operation and represent the quantity of metals recovered or paid for in the ore that was treated or sold during the year.

Statistics of mine production were first collected for Michigan for 1906. The mine census of all of the Central States was first undertaken for the year 1907. A comparison of the total production of these metals by States as reported from the mines and from the smelters will be found in the chapters on those metals in the complete volume, Mineral Resources of the United States.

The method of marketing and recording the mine output in the lead and zinc regions of the United States differs from that employed in the Western States. In the Western States the miner usually sells his ore according to the assay content of metal at a certain price per unit. In the lead and zinc regions of the Central States, however, where the material sold is principally concentrates,[1] payment is made according to a basis price for a certain quality of concentrates. The details of this method are given in the pages devoted to Missouri. The figures reported to the Survey by producers represent the quantity and assay content of concentrates sold and the amount received in payment. The total metal produced is calculated from the first two of these items.

The operators in Michigan report the quantity of concentrates produced and the actual recovery of copper from concentrates smelted.

In any year the mines may produce more or less concentrates than are smelted during the same period. The copper content of concentrates produced during the year but not smelted has been estimated on the basis of the average copper recovery per ton for the year of the company producing it.

[1] In local usage the ore as mined is called "dirt" and the concentrates are classed as "ore." Where the capacity of a concentrating plant is given, such capacity is to be understood as based on a 10-hour shift unless otherwise stated.

TENOR OF LEAD AND ZINC ORES OF THE CENTRAL STATES.

Much of the ore mined in the Western States is crude smelting ore, that is, it can be smelted directly without preliminary concentration. All but a very small portion of the ore from the Central States is of such tenor that it requires concentration. The only fair basis for comparison of the relative magnitude of mining operations in different States is that of tonnage of crude ore, or "dirt," as it is usually called in the Central States lead and zinc regions. However, in those States it is only the larger companies which make any record of the crude ore raised. In the Joplin and Upper Mississippi Valley regions the number of cans of ore hoisted is usually recorded and the approximate weight of the cans is generally known. Thus each company knows, in a general way, about what percentage of concentrates the mine run is yielding. Knowing the total production of concentrates and the average yield of concentrates from crude ores, one can arrive at a close estimate of the crude ore raised. Only the actual operating companies have the data, however, and it was the practice of the Survey, in order to shorten the list of producers as much as possible, to send requests only to the owners of the mining land or the companies holding first leases and to depend upon them to report the whole production of the tract. In 1911, 1912, and 1913 not only the first lessees of the land reported to the Survey, but also most of the sublessees gave data regarding both concentrates produced and "dirt" or ore milled. The tables of ore tenor which follow in the sections devoted to the respective States show the comparative percentages for the last two years. In certain States, notably Iowa, Kentucky, and the southern part of Illinois, it was not possible or advisable to make such calculations.

In Kentucky and southern Illinois the lead and zinc ores are recovered as by-products in the concentration of the fluorspar which they accompany. In Iowa since 1909, inclusive, the quantity of ore raised has been so small and the number of producers so limited that the calculation of averages and of the crude-ore production would be misleading.

Tenor of copper, lead, and zinc ores of Central States, 1911–1913.

State.	1911		1912		1913	
	Crude ore.	Metal content.[a]	Crude ore.	Metal content.[a]	Crude ore.	Metal content.[a]
	Short tons.	*Per cent.*	*Short tons.*	*Per cent.*	*Short tons.*	*Per cent.*
Arkansas	24,925	3.4	32,755	2.8	13,000	4.44
Illinois (northern)	153,313	3.6	147,859	3.6	119,200	2.9
Kansas	761,465	1.9	744,254	1.9	590,300	2.3
Michigan	10,978,827	1.0	11,411,941	.96	7,016,370	.968
Missouri	12,136,788	2.5	13,385,511	2.4	[b] 12,309,000	2.45
Oklahoma	224,450	2.9	293,500	3.1	581,100	3.57
Wisconsin	1,123,040	3.4	1,363,636	3.1	1,406,000	2.73
Total	25,402,808	.....	27,379,456	.....	22,034,970	.....

[a] The percentages given in this column represent the metal content of the ore in so far as it is recovered in the concentrates. In Michigan the metal so recovered is copper; in the other Central States the metals are lead and zinc, the relative proportions of which are shown in the table on another page and in the tables of ore tenor given in the sections devoted to the respective States.

[b] A small quantity of copper ore included.

This table shows that from silver, copper, lead, and zinc mines of the Central States, 22,034,970 short tons of ore were treated in 1913, compared with 27,379,456 tons in 1912. The decrease in 1913 of 5,344,000 tons was caused mainly by the strike in the Michigan copper-mining district, which had the effect of lessening the quantity of ore treated by about 4,400,000 tons. The ore production of the southwestern Missouri lead-zinc region declined about 1,000,000 tons. This decrease was due to the low price paid for blende concentrates during the latter part of 1913, which caused the curtailment of work in the "sheet ground" mines and lowered the yield of ore from 5,465,100 tons in 1912 to 4,303,900 tons in 1913. Less ore was mined and treated in northern Illinois, Arkansas, and Kansas in 1913 than in 1912, but the output from Oklahoma doubled.

The quantity of ore mined and treated from copper, lead, zinc, and lead-zinc mines in the Central States in 1913 was approximately only 6,450,000 tons less than the total ore of that description sold or treated by mines in both the Eastern and the Western States in 1912, and was 16 per cent of all the metallic ores from domestic mines sold or treated in 1912.

The low average tenor of the metal content of crude ore mined in the Central States in 1913 is best shown by the fact that the average value of the recoverable metal content was only $2.63 per ton of crude ore treated or 28 cents less per ton than in 1912.

PRODUCTION.

The total value of the mine output of silver, copper, lead, and zinc in the Central States in 1913 was $58,011,992, a decrease of $21,663,822 from the value for 1912 and an increase of only $1,685,289 over that for 1908. The total value of the production of these metals for the years 1908 to 1913, inclusive, was $385,398,786, of which $172,976,597 was for copper, $118,333,648 for zinc, $92,735,306 for lead, and $1,353,235 for silver.

SILVER.

The production of silver in the Central States in 1913 was 335,634 fine ounces, which at the average price of 60.4 cents per fine ounce (1.1 cents lower than in 1912) was valued at $202,723, as compared with 568,622 fine ounces, valued at $349,702, in 1912. Nearly all the silver that is produced in the Central States is recovered incidentally to the production of other metals. Of the 1913 production 295,173 ounces came from the copper lodes of Michigan, a decrease of 233,280 ounces resulting from a much lower copper output. About one-sixth of the concentrates from lead ores mined in southeastern Missouri were desilverized and yielded nearly all the production of silver from that State recovered in 1913; a small output of silver was also derived from copper ore, and the total recovery from Missouri amounted to 35,620 ounces in 1913.

The lead-zinc-fluorspar deposits of the Kentucky-Illinois field also carry silver, and from the lead concentrates derived from Illinois 3,541 ounces of silver were recovered, a decrease of 1,190 ounces. The only productive silver mine in the Central States in 1913 was one near Byars, in McClain County, Okla., which produced ore that yielded 1,300 ounces of silver, valued at $785.

COPPER.

The mine output of copper from the Central States in 1913 was from the States of Michigan and Missouri, the former State contributing nearly the entire output, which amounted to 136,429,613 pounds. The copper production of Michigan in 1913 was 135,853,409 pounds, which, at the average New York price of 15.5 cents a pound, was valued at $21,057,278, compared with a yield of 218,138,408 pounds, valued at $35,992,837, in 1912. The copper produced in Missouri in 1913, amounting to 576,204 pounds, valued at $89,312, was derived mainly from concentrates recovered in dressing the lead ores of southeastern Missouri, but part came from oxidized ore carrying copper and silver, which was shipped by the Cornwall Copper Mining Co. of Ste. Genevieve County, Mo.

The total production of copper from Michigan and Missouri in 1913 was 82,149,520 pounds less than in 1912, when the yield was less than in any year since 1907.

LEAD.

The mine production of lead in the Central States in 1913 was 187,701 short tone, which, rated at the average New York price for the metal for the year of 4.4 cents a pound ($88 a ton), was valued at $16,517,688, as compared with 186,891 short tons, valued at $16,820,190, in 1912. Although the output of lead increased 810 tons in 1913, the value decreased $302,502. In 1913 Missouri produced 93.8 per cent of the lead yield of the Central States, and the recoverable lead content of galena and lead carbonate concentrates mined in Missouri in 1913 equaled 40 per cent of the primary lead recovered in the United States from domestic ore. Of the total lead output of Missouri the "disseminated lead" district of southeastern Missouri produced 147,138 tons, again exceeding the yield from the Coeur d'Alene district of Idaho and retaining first place in lead production in the United States. Southwestern Missouri was the next largest producing district in the Central States, with an output of about 1,600 tons less than in 1912. Oklahoma increased its lead production about 2,890 tons, and its output was about 2,000 tons larger than the combined output of Wisconsin and Kansas, though in 1912 both Kansas and Wisconsin were larger producers of lead than Oklahoma.

ZINC.

The mine production of zinc in the Central States in 1913, based on mine returns with a deduction for separating and smelting losses, was 179,866 short tons, valued at $20,144,992. The value is computed at 5.6 cents per pound of spelter ($112 per ton), the average St. Louis price for the metal. The 1912 production was 191,307 short tons, valued (at $138 per ton) at $26,440,366. The decrease in 1913 was 11,441 tons in quantity and $6,295,374 in value. The output in 1913 was more than 32,800 tons larger than in 1908, and the value about $6,300,000 greater. The spelter production of the Central States was over 56.3 per cent of the total production of primary spelter from domestic ores in the United States in 1913, as compared with 59 per cent in 1912.

The State of Missouri, although the production declined about 12,000 tons, was again in 1913 much the largest producer of zinc in the United States. Its production was 124,963 tons, against 136,551

tons in 1912. Wisconsin produced 30,110 tons in 1913, against 33,050 tons in 1912. The output from Arkansas decreased 270 tons, that of Illinois 1,829 tons, that of Kansas 545 tons, and that of Kentucky 164 tons. The only one of the Central States which showed an increased yield of recoverable zinc in 1913 was Oklahoma, the output of which increased from 5,769 tons in 1912 to 11,664 tons in 1913.

SUMMARY OF PRODUCTION BY STATES.

The total value of the mine output of silver, copper, lead, and zinc in the Central States in 1913 was $58,011,992, as appears from the following table:

Mine production of silver, copper, lead, and zinc in the Central States in 1913, by States.

State.	Silver.		Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Pounds.*		*Short tons.*		*Short tons.*		
Arkansas					18	$1,584	478	$53,536	$55,120
Illinois	3,541	$2,139			959	84,392	2,236	250,432	336,963
Iowa					65	5,720			5,720
Kansas					2,427	213,576	10,088	1,129,856	1,343,432
Kentucky					22	1,936	327	36,624	38,560
Michigan	295,173	178,285	135,853,409	$21,057,277					21,235,562
Missouri	35,620	21,514	576,204	89,312	176,116	15,498,208	124,963	13,995,856	29,604,890
Oklahoma	1,300	785			6,228	548,064	11,664	1,306,368	1,855,217
Wisconsin					1,866	164,208	30,110	3,372,320	3,536,528
Total	335,634	202,723	136,429,613	21,146,589	187,701	16,517,688	179,866	20,144,992	58,011,992
Total, 1912	568,622	349,702	218,579,133	36,065,556	186,891	16,820,190	191,307	26,440,366	79,675,814
Total, 1911	550,184	291,598	220,480,513	27,560,064	188,669	16,980,210	172,698	19,687,572	64,519,444
Total, 1910	365,702	197,479	222,777,913	28,292,795	171,226	15,067,888	178,784	19,308,672	62,866,834
Total, 1909	301,629	156,848	234,136,529	30,437,749	168,221	14,467,006	175,337	18,936,396	63,997,999
Total, 1908	292,237	154,885	223,286,700	29,473,844	153,361	12,882,324	146,975	13,815,650	56,326,703

LEAD AND ZINC PRODUCTION BY REGIONS.

The productive lead and zinc territory in the Central States naturally falls into seven regions, three of which are not limited to any single State. For statistical purposes the tables showing the production of lead and zinc by States are necessary and are so given.

For practical purposes, however, it seems desirable to compile the production by the natural regions irrespective of State lines.

The seven regions are as follows, in order of importance of output: (1) The Joplin region, comprising the district in southwestern Missouri, southeastern Kansas, and northeastern Oklahona; (2) southeastern Missouri, containing the great disseminated lead deposits; (3) the upper Mississippi Valley region, including all the lead and zinc mines in southwestern Wisconsin, Iowa, and northwestern Illinois; (4) the Kentucky-Illinois fluorspar region in southern Illinois and northern Kentucky; (5) northern Arkansas; (6) Central Missouri;[1] (7) the Arbuckle Mountain region in southern Oklahoma.[2]

The southeastern Missouri region produced about 80 per cent of the lead output of the Central States, and about 33.8 per cent of the production of lead receovered from domestic ore in the United States in 1913. The Joplin region produced 19.8 per cent of the

[1] Owing to the small output from the central Missouri region it has in this report, for convenience, been included in the southeastern Missouri region.

[2] No production reported in 1913.

lead and 81.4 per cent of the zinc of the Central States in 1913, and was much the largest producer of zinc in the United States, yielding about 43.4 per cent of the total spelter production from domestic ores. The upper Mississippi Valley region produced a little more than 1 per cent of the lead and 18 per cent of the zinc produced in the Central States in 1913.

Mine production of lead and zinc in the Central States in 1913, by regions, in short tons.

Region.	Concentrates.				Total value of concentrates.
	Lead.[a]		Zinc.[b]		
	Quantity.	Value.	Quantity.	Value.	
Joplin	37,216	$2,425,201	291,110	$11,214,318	$13,639,519
Southeastern Missouri [c]	219,511	9,580,893	672	14,065	9,594,958
Upper Mississippi Valley	3,367	169,856	106,931	2,242,377	2,412,233
Kentucky-Southern Illinois	547	24,784	894	19,017	43,801
Northern Arkansas	23	1,179	1,274	31,966	33,145
Total	260,664	12,201,913	400,881	13,521,743	25,723,656
Total, 1912	269,433	12,620,234	424,337	17,952,479	30,572,713

Region.	Metal.				Total value of metal.
	Lead.		Zinc.		
	Quantity.	Value.	Quantity.	Value.	
Joplin	37,213	$3,274,744	146,474	$16,405,088	$19,679,832
Southeastern Missouri [c]	147,558	12,985,104	241	26,992	13,012,096
Upper Mississippi Valley	2,519	221,672	32,346	3,622,752	3,844,424
Kentucky-Southern Illinois	393	34,584	327	36,624	71,208
Northern Arkansas	18	1,584	478	53,536	55,120
Total	187,701	16,517,688	179,866	20,144,992	36,662,680
Total, 1912	186,891	16,820,190	191,307	26,400,366	43,222,556

[a] Includes both galena and lead carbonate concentrates.
[b] Includes sphalerite, zinc carbonate, and zinc silicate concentrates
[c] Includes a small production from the central Missouri region.

ARKANSAS.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Arkansas in 1912 and 1913 is shown in the following table:

Mine production of lead and zinc in Arkansas, 1908–1913, in short tons.[a]

Year.	Ore.						Metal content.			
	Lead concentrates, (galena).		Zinc concentrates.				Lead		Zinc.	
			Sphalerite.		Silicate and carbonate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1913	23	$1,179	594	$16,916	680	$15,050	18	$1,584	478	$53,536
1912	39	2,180	1,419	56,235	462	11,231	31	2,790	748	103,224
1911	80	4,321	1,407	40,425	183	4,239	64	5,760	664	75,696
1910	80	3,714	1,857	74,136	128	2,641	63	5,544	994	107,352
1909	30	1,800	896	33,948	98	2,736	24	2,064	510	55,080
1908	18	985	516	18,270	939	21,469	15	1,260	605	56,870

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in the case of zinc, but not in case of lead. In comparing the values of ore and of metal it should be borne in mind that the values given for the ore is that actually received by the producer, whereas the value of the metal is calculated from the average daily quotations at New York and St. Louis.

Tenor of lead and zinc ore and concentrates produced in Arkansas in 1912 and 1913.

		1912	1913
Total crude ore sold	short tons	32,755	13,000
Total concentrates in crude ore:			
Lead	per cent	.1	.17
Zinc	do	5.7	9.8
Metal content of crude ore:			
Lead	do	.1	.14
Zinc	do	2.7	4.3
Average lead content of galena concentrates	do	79.5	78.3
Average zinc content of sphalerite concentrates	do	49.0	48.0
Average zinc content of zinc silicate and carbonate	do	38.0	40.6
Average value per ton:			
Galena concentrates		$55.90	$51.24
Sphalerite concentrates		39.63	28.48
Zinc silicate and carbonate		24.31	22.13

NORTHERN ARKANSAS.

Lead and zinc deposits have been known in Arkansas for many years. Lead was noted by Schoolcraft in his travels in 1819, and has been mined in a desultory way since the settlement of the State. Present development dates from about 1899, when there was a great rush to the northern Arkansas field. The mines are principally in Boone and Marion counties and in the adjoining portions of Searcy and Newton counties, though there are also numerous mines and prospects in Baxter, Izard, Sharp, Lawrence, and other counties to the east, and deposits have been worked in Washington and Sevier counties, on the extreme western border of the State, in the last two years.

The ores are galena, sphalerite, and smithsonite, and the concentrates produced are generally high grade and free from or very low in iron or lime. The sphalerite has frequently assayed 2 or 3 per cent above the price basis of 60 per cent metallic zinc content. In 1913, as in 1912, nearly all the concentrates classed as sphalerite was mixed sphalerite and zinc carbonate averaging 48 per cent zinc content and mined from shallow workings. The sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, a yellow variety of smithsonite, known locally as "turkey fat" and showing as high as eight-tenths of 1 per cent of cadmium. The ore bodies occur in fissures or crevices, in fault breccias, and in solution breccias. The ore deposits are for the most part found in limestone of early Ordovician age, but some also are found in the Boone limestone, of Mississippian (lower Carboniferous) age.

Although not so advantageously situated as the mines in the Joplin region, most of the productive properties in northern Arkansas since the completion of the White River branch of the St. Louis, Iron Mountain & Southern Railway and of the St. Louis & North Arkansas Railroad are within 12 miles of railway transportation. The longer railway haul being taken into consideration, ore prices compare favorably with other regions and royalties paid landowners average the same as in Missouri. There are in Arkansas about 20 concentrating plants of the Joplin type, averaging about 100 tons in daily capacity; but most of them have not been operated in recent years. In 1913 not a single concentrating plant was operated, though at two mines steam crushers were used in conjunction with hand jigs. Wood is universally used for fuel and costs about $2.50 a cord delivered at the

mine. Mining methods are similar to those in vogue in the Joplin region except that, owing to the rugged character of the country, many deposits of ore outcrop on the hillsides and have been followed in by tunnels.

In view of the fact that the production of zinc has declined in 1912 and 1913 and that so many plants remain idle in Arkansas, notwithstanding workable ore deposits are known to exist, some apparent reasons are cited. Most of the properties when first opened labored under the disadvantage of long wagon hauls, high freight rates, and lack of keen competition among ore buyers. Other mines were equipped with expensively built concentrating plants erected before the ore bodies were adequately developed. Many properties were not only extravagantly but also incapably managed, and investors' money went largely to pay overhead expenses. Many deposits were equipped with useless plants that could have been profitably operated on a small scale. This has been demonstrated during the last two years, as is shown by the increased shipments of hand-cobbed or hand-jigged concentrates.

Furthermore, three of the present disadvantages of mining the numerous ore deposits in practically all the Arkansas districts are (1) the loss of time in obtaining supplies and repairs, (2) the small number of capable miners like those who prospect and mine the shallow diggings in the Joplin region, and (3) the long wagon hauls over bad roads from the mines to the railways. Much of the ore in the Joplin region is loaded on cars for 50 cents to $1 per ton and several tons can be hauled over the excellent roads by one team. It costs $3 a ton to ship concentrates from some of the Arkansas camps, and the load hauled is usually less than 2,800 pounds. With improved roads and the more active working of the shallow deposits of carbonate ore the shipment of concentrates from Arkansas will show a large increase. The production will likely increase in 1914; for the large concentrating plant at the Morning Star mine in the Rush district will be operated and one or more mills in the Zinc district will contribute an output which was entirely lacking in 1913.

The assistance rendered by Prof. R. W. Willett, of Yellville, in the preparation of this account of the lead and zinc production of Arkansas is very gratefully acknowledged.

In 1913 there were 18 shippers of lead or zinc concentrates, compared with 17 in 1913, and the value of the mine output of lead and zinc was $55,120. There were only 3 producers of lead concentrates and the shipments declined from 39 tons in 1912 to 23 tons in 1913. The production of sphalerite concentrates was 594 tons, or 825 tons less than in 1912. This large decline in output was caused by the closing down of all the large concentrating plants. The sales of zinc carbonate concentrates increased from 462 tons in 1912 to 680 tons in 1913, and the average zinc content increased 2 per cent. As all the concentrates were hand cobbed or hand jigged the tonnage of ore handled declined over 19,000 tons and the average recovery of concentrates from ore increased materially. Nearly all of the concentrates sold that are classed as sphalerite were mixed sphalerite and carbonate in the approximate proportion of 3 to 1 and averaged about 48 per cent zinc content.

REVIEW BY DISTRICTS.

Dodd City district.—The only production reported from this district in 1913 was a small quantity of zinc carbonate from the Markle land. The Rising Sun, North Star, Beatty, Governor Eagle, Pilot Rock, and Nakomis mines were all idle.

Maumee district.—The Maumee mine, which is equipped with a 100-ton concentrating plant, was idle and late in 1913 was taken over by the Maumee Zinc Co. For the first time in several years there was no production by lessees of the Granby Mining & Smelting Co.

Rush district.—The mines of the Rush district in Marion County produced nearly all the sphalerite, mixed sphalerite and zinc carbonate concentrates, and 55 per cent of the zinc carbonate concentrates shipped from Arkansas in 1913. The Red Cloud mine produced 70 per cent of the sphalerite concentrates shipped in 1913. The mine is opened by a tunnel and the property is equipped with a 200-ton mill which was not operated. The concentrates shipped were mixed sphalerite and zinc carbonate, averaged 47 per cent zinc, and contained no appreciable iron or lime. The Red Cloud mine was under the management of J. Conness Shepherd, who also leased and operated the Morning Star, Frank Carney, and Climax mines. Owing to litigation, possession of the 200-ton concentrating plant at the Morning Star mine could not be given the lessee until late in December, 1913, so that the entire output of the Morning Star mine was of lump sphalerite and hand-cobbed zinc carbonate. The zinc carbonate was high grade, averaging 42 per cent zinc content, and the production amounted to over 50 per cent of the Arkansas output in 1913. The concentrating plant was overhauled in December, 1913, and put into operation early in 1914, and it is producing a mixed sphalerite and zinc carbonate concentrate. The Climax mine, which is about 3 miles nearer Yellville than the Morning Star mine, was operated by means of 2 tunnels. The equipment consists of a steam hoister, crusher, and rolls, and 5 hand jigs, producing sphalerite concentrates averaging 53 per cent zinc content. The ore body at the Climax is different from the deposits at the Morning Star; the zinc is mined in hard blue and gray flint, and the concentrates produced contain no zinc carbonate and are chatty though free from iron. The Yellow Jacket (Philadelphia) mine and 100-ton mill were idle nearly all the year and the production was small. The Silver Hollow mine which adjoins the Red Cloud was idle, but the mill was put in repair ready to operate early in 1914. The Cave Springs mine near Yellville was worked by J. H. Hand, and small shipments of sphalerite and zinc carbonate were made.

Zinc and Sugar Orchard districts.—The mines in the Zinc and Sugar Orchard districts in Boone County, although none of the concentrating plants were operated, were the second largest producers of zinc concentrates in Arkansas in 1913. The principal shipper was L. L. Brown, who operated the Gloria, Frisco, Bolinger and Cantrell, Gladstone, and other mines. Most of the ore shipped was hand-cobbed zinc carbonate obtained by means of tunnels. The Gloria mine is equipped with hand jigs, and there is a large quantity of fine "dirt" awaiting treatment. The Brown properties are near Zinc, and the wagon haul to the railway is short and over better roads than are usual in Arkansas mining districts.

The Madison 100-ton mill was not operated in 1913, but the mine was leased to the Doolen Mining Co. and a fair output of zinc carbonate was made. There were several smaller producers of zinc concentrates, and nearly all the galena concentrates produced in Arkansas in 1913 were shipped from Zinc. This galena was derived from the J. E. Wheeler lease of the Washington Mining Co. land and from the Jones, Reegan, and Davidson lands near Monarch. The Iola, Almy, and Tar Kiln mines, all equipped with mills and all amongst the largest producers in Arkansas, were idle in 1913. The Jack Pot mine of the Earl Mining Co. has been leased to T. E. McClure and others of Aurora, Mo., and a concentrating plant is to be built.

Boxley district.—The only production from this or any other district in Newton County in 1913 was a small quantity of galena shipped by N. B. Whiteley, of Ponca. The Bennett, Keys, and Spanish LeMarr mines were all idle.

ILLINOIS.

By J. P. Dunlop.

PRODUCTION.

The production of silver, lead, and zinc in Illinois in 1913 is shown in the following tables:

Mine production of lead and zinc in Illinois in 1913, in short tons.[a]

District.	Ores.					
	Lead concentrates (galena).		Zinc concentrates.			
			Sphalerite.		Zinc carbonate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Northern Illinois	753	$40,509	8,148	$156,664	120	$1,603
Southern Illinois	507	23,362	.....	.....	.....	.....
	1,260	63,871	8,148	156,664	120	1,603
Total, 1912	1,661	86,497	13,464	367,537	.....	.....

District.	Metal content.			
	Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.
Northern Illinois	588	$51,744	2,236	$250,432
Southern Illinois	371	32,648	.....	.....
	959	84,392	2,236	250,432
Total, 1912	1,282	115,380	4,065	560,970

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in the case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the metal is calculated from the average daily quotations at New York and St. Louis.

Mine production of silver in southern Illinois, 1909–1913.

Year.	Silver.		Lead concentrates, silver-bearing.	
	Quantity.	Value.	Quantity.	Ounces of silver per ton.
	Fine oz.		*Short tons.*	
1909	1,011	$526	259	3.90
1910	2,022	1,092	398	5.08
1911	3,036	1,609	482	6.25
1912	4,731	2,909	748	6.31
1913	3,541	2,139	507	7.00

Tenor of lead and zinc ore and concentrates produced in Illinois, 1912 and 1913.

	1912	1913
NORTHERN ILLINOIS.		
Total crude ore, short tons	147,859	119,200
Total concentrates in crude ore:		
Lead, per cent	0.6	0.6
Zinc, do	9.1	6.9
Metal content of crude ore:		
Lead, do	.4	.5
Zinc, do	3.2	2.4
Average lead content of galena concentrates, do	79.5	78.1
Average zinc content of sphalerite concentrates, do	35.4	34.8
Average zinc content of zinc carbonate concentrates, do	.....	29.5
Average value per ton:		
Galena concentrates	$55.38	$53.80
Sphalerite concentrates	$27.30	$19.23
Zinc carbonate concentrates	.....	$13.36
SOUTHERN ILLINOIS.		
Average lead content of galena concentrates, per cent	74.6	73.3
Average value per ton of galena concentrates	$46.49	$46.08

The lead concentrates produced in southern Illinois are recovered in concentrating the fluorspar. To speak of the total crude ore raised as crude-lead ore would be misleading. No attempt has been made, therefore, at calculating the quantity or the tenor of the crude ore.

The value of the mine production of silver, lead, and zinc in Illinois in 1913 was $336,963, as compared with $679,259 in 1912. The lead concentrate produced amounted to 1,260 short tons, which was 401 tons less than in 1912, and the metal content decreased from 1,282 tons in 1912 to 959 tons in 1913.

The output of sphalerite concentrate decreased from 13,464 tons in 1912 to 8,148 tons in 1913, and the recoverable zinc content of the concentrates decreased from 4,065 tons in 1912 to 2,236 tons in 1913, and the value was $310,538 more in 1912 than in 1913. There was also 120 tons of zinc carbonate valued at $1,603 shipped in 1913.

The silver recovered from lead concentrates smelted amounted to 3,541 fine ounces, valued at $2,139, against 4,731 fine ounces, valued at $2,909, in 1912.

The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineralogical association and structural environment. Those of southern Illinois belong to the Kentucky-Illinois fluorspar district; those of northern Illinois belong to the upper Mississippi Valley region.

NORTHERN ILLINOIS.

The lead and zinc mines of northern Illinois are all in Jo Daviess County, the extreme northwest county of the State. The ores have the same structural relations as in the upper Mississippi district generally; that is, they occur disseminated through the limestone, or in openings in it called "crevices," "pitches," or "flats," depending on their attitude to the horizontal. These openings have, in general, an east and west trend, known as their "range." The ore bodies are sometimes continuous for long distances along these "ranges," which for that reason largely control the prospecting, both by shafts and by drilling. The ore deposits occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age.

The ores are galena, smithsonite, and sphalerite, though the two latter are much less common now than formerly, when the deposits worked were mostly shallow and above water level. In early years the galena ores only were mined and the ore was taken from shallow pockets in quantities ranging from a few tons to several thousand. Some idea of the importance of the early mining of galena can be formed by the figures of production taken from the Galena city directory which gives a total output of about 389,720 tons of galena concentrates produced in the upper Mississippi Valley region between the years 1821 and 1857. Although the lead output of northern Illinois, Wisconsin, and Iowa, has been large, the output in recent years has been comparatively small and no ores have been smelted in those States.[1] The galena is practically nonargentiferous, and the zinc ores are not known to contain cadmium. Iron pyrites is very commonly associated with the ores, frequently in such quantity as to necessitate roasting and magnetic separation. None of the concentrating plants have calciners or roasters and magnetic separators attached, but there is a custom roaster and separator operated by the Joplin Separator Co., at Galena, Ill. There were also separating plants operated near by in Wisconsin by the Campbell Magnetic Separating Co., at Cuba City; the National Zinc Separating Co., at Hazel Green; the Wisconsin Separating Co., at Benton; the Mineral Point Zinc Co., at Mineral Point; the Linden Zinc Co., at Linden; and the Vinegar Hill Zinc Co., at Platteville. In 1913 about 90 per cent of the zinc concentrates were shipped to separating plants, mainly to those in Wisconsin.

As none of the operators in the Sand Prairie district and only one lead mine in the Elizabeth district reported any production in 1913, the entire output of northern Illinois is included under the Galena district. The production of lead concentrates was 753 tons, valued at $40,509, as compared with 864 tons, valued at $47,847, in 1912.

There were 8,148 tons of sphalerite concentrates, valued at $156,664, produced in 1913, a decrease of 5,316 tons in quantity and of $210,873 in value, compared with the output in 1912. The average price per ton received for sphalerite concentrates was about $8 less than in 1912.

The yield of zinc carbonate from the Galena district amounted to 120 tons, averaging 35 per cent zinc content and valued at $1,603.

The tonnage of crude ore mined decreased from 147,859 tons in 1912 to 119,200 tons in 1913. The zinc concentrates in the ore milled

[1] Pulsifer, H. B.: History of lead smelting in Wisconsin: Min. and Eng. World, May 2, 1914, p. 821.

showed a decrease of 2.2 per cent, while the percentage of lead remained the same as in 1912.

The average zinc content of the sphalerite concentrate was about the same—35.4 per cent in 1912 and 34.8 per cent in 1913.

Although the shipments of galena showed a small decrease and those of sphalerite a large decrease in 1913, when compared with 1912, development work was more active than it was in previous years. Several old mines were reopened and with one new property were producing late in the year, so that the output in 1914 will probably greatly exceed that for 1913 unless ore prices decline to a point which would render mining unprofitable.

REVIEW BY DISTRICTS.

Elizabeth district.—The only active mine in this district was the Eadie, operated by the Vinegar Hill Zinc Co. The shaft at this mine was sunk 90 feet and a good output was made of high-grade hand-cobbed galena. The mine is not equipped with a mill, and no zinc concentrates were shipped.

Galena district.—The Galena district includes the mines in the vicinity of Fever River from Mississippi River to the Wisconsin State line. For many years the principal production was of lead ores, but in recent years the principal output has been zinc ores. The production of galena concentrates, however, has increased from 126 tons in 1910 to 864 in 1912 and to 753 tons in 1913. Over 47 per cent of the sphalerite concentrates and one-third of the galena were produced by the Vinegar Hill Zinc Co. from the Vinegar Hill mine. The Unity mine, formerly a large producer, was not operated but some prospect drilling was done on the property. Both the Vinegar Hill and the Unity mines are equipped with 100-ton concentrating plants, operated with electric power supplied by the Interstate Light & Power Co. Prospect work only was done on the Lake Superior and Hughlett & Gray tracts.

The Northwestern Zinc Co.'s production of sphalerite increased over 25 per cent, and its output of galena concentrates was only exceeded by that of the Vinegar Hill Zinc Co. The mine, which is on the Stacy land, has a 100-foot shaft and is equipped with a 100-ton mill.

At the old Marsden-Black Jack mine the 200-ton mill was entirely rebuilt, an electric drive was installed, and a double-compartment shaft was sunk 150 feet. Owing to the large amount of development work, the concentrating plant was not operated until late in 1913. In December the mine was producing at the rate of 300 tons of 35 per cent concentrates per month.

The Great Western Lead Manufacturing Co. leased the Mary Brown land and sunk a 136-foot shaft after prospect drilling had shown a promising ore body. The old 100-ton Calvert mill at Benton was purchased and rebuilt at the property. The mill was running and shipments of concentrates were made early in 1914.

The Betsey mine on the Weinschenk land, which was purchased by the Indianapolis Lead & Zinc Co., made a fair output of galena and also of zinc carbonate concentrates. The shaft at this mine is 106 feet deep and the concentrating plant has a capacity of 75 tons. Some galena was recovered by the Josephine Mining Co. while prospecting on the Doolin land.

The Ten Strike Consolidated Mining Co. abandoned the Ten Strike mine and operated only the Merry Widow and the White Rose mines in 1913. Galena ore was produced at the White Rose, which has three shafts, the deepest being 71 feet. The old shaft at the Merry Widow, which was 112 feet deep, was abandoned after the mine caved in March and a new shaft to reach the ore body at a depth of 120 feet was being sunk. The Merry Widow which is equipped with a 100-ton mill has been the largest producer of galena in northern Illinois in the last few years.

The Glen Ridge mine near the Marsden-Black Jack mine was operated for the first three months only of 1913, producing some sphalerite concentrates which averaged 32 per cent zinc content. The concentrating plant has a capacity of 100 tons and the two shafts are 112 feet deep.

SOUTHERN ILLINOIS.

The lead and zinc deposits of southern Illinois are found in Pope and Hardin counties in rocks of lower Carboniferous age, in the northern extension of the Kentucky-Illinois fluorspar district. The structural relations and the mineralogic association are similar to those of the deposits of western Kentucky and in striking contrast to those of the deposits of northern Illinois. The ores occur in fissure veins, in association with jointing and faulting. The mines have been worked to depths of 300 and 500 feet without disclosing any decrease in the dimensions of the ore bodies. Dikes and sheets of lamprophyre and dikes of mica peridotite occur in the vicinity, but not in direct connection with the ore deposits. Galena is the most important metallic mineral. Formerly, and nearer the surface, large bodies of galena were worked, but it is at present produced incidentally in the concentration of the fluorspar. For this reason it would be misleading to give the tonnage of crude ore. As the district is not reached by railway, the product of the mines is dependent on river transportation.

The galena of southern Illinois is notably argentiferous as compared with the rest of the Mississippi Valley ores, the silver content ranging up to 12 and 14 fine ounces per ton of lead concentrates, and averaging for the last five years from 4 to 7 fine ounces per ton of lead concentrates. Sphalerite, or zinc blende, is the next important metallic mineral, but it occurs much less plentifully than galena. It is recovered as zinc middlings in the concentration of the fluorspar. The difficulty of making a clean separation of the zinc middlings has kept down the production of zinc. None has been sold from southern Illinois in the last five years. The principal vein minerals are fluorspar, calcite, and barite.

The output of galena concentrates decreased 290 tons in quantity, and the silver content recovered in treating the concentrates decreased from 4,731 ounces in 1912 to 3,541 ounces in 1913. The average lead content of the concentrates declined from 74.6 per cent in 1912 to 73.3 per cent in 1913. The average silver content per ton recovered from lead concentrates, which was only 3.90 fine ounces in 1909, increased from 6.31 in 1912 to 7 ounces in 1913. The steady yearly increasing recovery of silver per ton of concentrates apparently indicates that the galena recovered from fluorspar mined at the lower levels contains the greater silver content.

The decreased output of lead concentrates was caused chiefly by the flooding by Ohio River of the Rosiclare mine, the largest producer in the region, though the Fairview mine, the only other large producer, also reported smaller shipments of galena in 1913.

The Fairview Fluorspar & Lead Co. operates on the Good Hope vein, which was first developed in 1862. The workings in 1913 were reached by three shafts, of which the Good Hope is 505 feet deep; No. 4, 275 feet deep; and Blue Diggings, 290 feet deep. Nearly one-half of the fluorspar was mined from the Blue Diggings shaft at the 200-foot level. This shaft was sunk from 200 feet to 290 feet, and 600 feet of drifting was done on the 200-foot level. The railway was extended to this shaft from No. 4 shaft, connecting all shafts to the mill and river. The Good Hope shaft was abandoned below the 281-foot level on account of the increased flow of water which had reached 1,200 gallons per minute on the 475-foot level. An Ingersoll-Rand air compressor and a 250-horsepower boiler were added to the surface equipment. The concentrating plant at the mine has a capacity of 250 tons.

The Rosiclare Lead & Fluorspar Co., which is the largest producer of fluorspar and lead concentrates in southern Illinois, operates on an ore body which is probably continuous with that of the Fairview. The workings have reached a depth of 300 feet, and the mine has a long record of continuous production. The steel and concrete mill, entirely fireproof, is designed to handle 500 tons a day, and is provided with special facilities for saving the lead and zinc.

The mine of the Evansville Lead & Spar Co. was sold to the Lead Hill Lead & Fluorspar Co. in 1913, and mining was suspended until the new owners explored the property by means of a core drill.

IOWA.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Iowa in 1913 is shown in the following table:

Production of lead and zinc in Iowa in 1908–1913, in short tons.[a]

District.	Ore.						Metal content.			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Carbonate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Dubuque:										
1913	83	$4,150	.....	.....	.....	.....	65	$5,720	.....	.....
1912	78	3,900	.....	.....	.....	.....	63	5,670	.....	.....
1911	75	3,750	.....	.....	.....	.....	60	5,400	.....	.....
1910	25	1,320	245	$5,740	.....	.....	20	1,760	96	$10,368
1909	45	2,079	.....	.....	100	$1,500	36	3,096	35	3,780
1908	63	3,613	829	23,183	.....	.....	51	4,284	395	37,130

[a] In calculating the metal content of the ore from assays, allowance has been made for smelting losses in the case of zinc, but not in the case of lead. In comparing the value of ore and metal content it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

It is not deemed advisable to publish figures of the total crude-ore production of Iowa for 1913. The output of concentrates was made up of small lots obtained as the result of development work, and these are not a fair clue to the average ore tenor. As noted below, the ores occur under much the same condition as in Wisconsin, and the averages reached for that State would hold reasonably well for Iowa.

The lead and zinc deposits of Iowa extend along Mississippi River for nearly 80 miles, in Dubuque, Clayton, and Allamakee counties. They are found in the Galena dolomite, of Ordovician age. In early days the Dubuque mines were the most important source of lead in the United States, and in later years the mines, especially those in the vicinity of Durango, yielded considerable quantities of zinc carbonate ore. Nearly all this earlier mining was done above water level, and only within the last few years has there been much attempt to mine below water level. Therefore the production, particularly of zinc-blende ore for these years, though small, is noteworthy, since it represents the attempt to mine at deeper levels.

The ore deposits of the Dubuque district occur in crevices and in caves or "openings" along these crevices. Of these openings there are five or six, the "top," "middle," and "third" being the most prolific of ore. The "flats" and "pitches" common in the Wisconsin mines have been found in only one or two instances in Iowa. The crevices have an east-west trend and sometimes extend considerable distances, being mined at different places, in which case they are known as "ranges." The mining operations of recent years have generally been confined to attempts to find paying ore at deeper levels in these old ranges, which are known to have yielded ore in former days in the upper openings.

The only production of lead in the Dubuque district in 1913 was 83 short tons of lead concentrates, sold in small lots. No sales of sphalerite concentrates were reported. The Aguanico Mines Development Co. (formerly the Avenue Top), in the western part of Dubuque, did not operate either the workings or the 100-ton concentrating plant. The Bellman, Fitzpatrick, Big Joe, Byrne & Saul, Grand View, Harriman, Lore, and Pikes Peak mines were idle the entire year.

The only active properties in the district in 1913 were the Goosehorn, Isborn, and Hohman. At the Isborn and Hohman the work accomplished was some timbering and a slight amount of prospecting. The Goosehorn mine is equipped with a small concentrating plant which was operated during part of the year, though none of the lead and zinc concentrates produced were shipped. The ore milled was taken from two shafts, each about 190 feet deep.

All of the lead ore came from prospects operated by means of shallow shafts, the miners being paid a certain daily wage and a portion of the selling price of the lead recovered. Many of the large companies ceased operating and surrendered their charters. Some lead will continue to come from the small mines, but the present outlook is not favorable for any large output of zinc from the deep workings.

KANSAS.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Kansas in 1913 is shown in the following table:

Production of lead and zinc in Kansas in 1913, by districts, in short tons.[a]

District.	Ores.								Metal content.			
	Lead concentrates.				Zinc concentrates.				Lead.		Zinc.	
	Galena.		Carbonate.		Sphalerite.		Carbonate and silicate.		Quantity.	Value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.				
Galena	3,041	$154,718	2	$43	16,340	$638,873	198	$3,194	2,380	$209,440	8,096	$906,752
Badger-Peacock	24	1,215			294	10,795			18	1,584	153	17,136
Lawton	37	2,086			3,399	143,366			29	2,552	1,839	205,968
State total:												
1913	3,102	158,019	2	43	20,033	793,034	198	3,194	2,427	213,576	10,088	1,129,856
1912	3,003	158,798	33	1,335	21,258	1,005,509	125	3,152	2,371	213,390	10,633	1,467,354

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in the case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

Tenor of lead and zinc ore and concentrates produced in Kansas, 1912 and 1913.

		1912	1913
Total crude ore	short tons	744,254	590,300
Total concentrates in crude ore:			
Lead	per cent	0.4	0.5
Zinc	do	2.8	3.5
Metal content of crude ore:			
Lead	do	.3	.4
Zinc	do	1.6	1.9
Average lead content of galena concentrates	do	78.3	78.2
Average lead content of lead carbonate concentrates	do	51.5	.....
Average zinc content of sphalerite concentrates	do	55.4	55.7
Average zinc content of zinc silicate and carbonate	do	39.2	35.9
Average value per ton:			
Galena concentrates		$52.88	$50.94
Lead carbonate concentrates		40.45	.....
Sphalerite concentrates		47.30	39.58
Zinc silicate and carbonate		25.30	16.13

The lead and zinc deposits of Kansas, so far as developed, are limited to the southeastern portion of the State, in Cherokee County. They comprise the western extension of the ore deposits of the Joplin region and display the general characteristics of that area, except that here typical sheet-ground deposits have not been extensively developed. The ores are galena and lead carbonate, sphalerite or zinc blende, and zinc carbonate and silicate. The galena is practically nonargentiferous, carrying but a small fraction of an ounce of silver to the ton of lead concentrates.

The value of the mine production of lead and zinc in Kansas in 1913 was $1,343,432, as compared with $1,680,744,in 1912. Most of the decrease was caused by the decline in the average price of spelter from $138 a ton in 1912 to $112 a ton in 1913. The decrease in zinc content of sphalerite concentrates in the Galena district was about 1,400 tons, but this loss was partly offset by an increase of almost 100 per cent in the output of Lawton district. The value of the lead recovered in Kansas was only about $200 less in 1913 than in 1912. The production of galena concentrates increased from 3,003 tons in 1912 to 3,102 tons in 1913, and the quantity of lead carbonate concentrates decreased from 33 tons, valued at $1,335, in 1912, to 2 tons, valued at $43, in 1913. The total value of all lead concentrates was about $2,000 less in 1913 than in 1912. The metal content of these lead concentrates shipped in 1913 was 2,427 tons, valued at $213,576. The percentage of lead concentrates in crude ore milled increased from 0.4 per cent in 1912 to 0. 5 per cent in 1913. The average lead content of the galena concentrates was only 0.1 per cent less in 1913 than in 1912, but the average price received for concentrates declined nearly $2 a ton.

The production of zinc carbonate and silicate amounted to 198 tons, valued at $3,194, which was 73 tons more than in 1912. The value of the concentrates was about the same in 1913 as in 1912, a condition due to the considerably lower zinc content of the concentrates and the large decrease in average prices received.

The production of sphalerite concentrates in 1913 was 20,033 tons, valued at $793,034, which was a decrease of 1,225 tons in quantity and of $212,475 in value. With a smaller quantity of ore mined from the blanket ground in 1913 the proportion of sphalerite concentrates recovered from crude ore milled increased from 2.8 per cent in 1912 to 3.5 per cent in 1913. The quantity of crude ore treated decreased about 150,000 tons and the value of the sphalerite concentrates sold was about $8 per ton less than in 1912. The increase of 0.3 per cent in the average zinc content of the sphalerite was due to the larger quantity of high-grade concentrates from the Lawton district.

All Kansas districts considered, there was more prospecting done in 1913 than in 1912, and at the end of the year conditions were such that with higher ore prices the State production could be considerably increased. Many old mining tracts at Galena changed owners and some new mills were built, and though less sphalerite concentrates were sold than in 1912 considerable mill dirt was not treated or sold. Little mining was done in the Badger-Peacock district. The Lawton camp was one of the most active in the Joplin region, though the increased output resulted from only one of the many new mines attaining the producing stage. Prospecting was continued near Blue Mound just north of the State line between Oklahoma and Kansas. Leases acquired in 1913 will be drilled in 1914, and it is hoped that new territory similar to that in the North Miami field will be developed.

REVIEW BY DISTRICTS.

Badger-Peacock district.—The underground workings of the old mines in this district remained flooded in 1913. It was proposed to remove the United Lehigh mill from Carl Junction, Mo., to the camp and for the owners of the various mining tracts to cooperate in the heavy expense of draining the mines. Low prices for ore held back

the consummation of this plan, and in consequence the output from the old mining tracts was confined to concentrates obtained by the treatment of tailings and sludge. The Early Bird mill on the J. B. Meredith lease of the Middlesex Land & Mining Co.'s property was operated until September, 1913, when it was destroyed by fire. The only production reported from the lands of the United Zinc Co. was made by scrappers, and the Hubbard land was idle until leased late in the year by the Kramer Mining Co., which confined its work to drilling.

The 200-ton concentratiag plant on the T. R. Lynas land was operated during part of the year and produced the greater part of the district output. A new shaft was sunk to the 100-foot level and a drill was operated extensively. The production of the mine developed on the Phebus land east of Badger close to the Kansas-Missouri State line is included in the Badger-Peacock output. The first lease on the Phebus land is held by the Missouri-Kansas Development Co., and is subleased to the Joplin-Columbus Mining Co. The ground was drilled and a shaft was sunk to a depth of 140 feet in soft confused ground. The dirt hoisted was treated by 6 hand jigs yielding a good output of high-grade sphalerite concentrates.

Lawton district.—This district, which is situated 3½ miles north of Badger-Peacock and 14 miles northwest of Joplin, was first prospected about 1900, but did not attain prominence as a producing camp until 1911. The output doubled in 1912 and again doubled in 1913. The only productive leasehold has been that of the Eastern Lead & Zinc Co., which drilled a large area by means of churn drills, sunk shafts, and erected a 250-ton electrically equipped concentrating plant. The company's production has steadily increased and its sublessees have developed ore bodies, one of which reached the producing stage late in 1913. Shafts have been sunk on other leases, and mills were under construction on the Eastern and on adjoining lands. The ore bodies appear to be extensive, the ground requires little timbering, and the dirt is said to average about 5 per cent in concentrates of high grade.

The ground worked by the Eastern Lead & Zinc Co. is opened by 3 shafts, of which the mill shaft is 132 feet deep; No. 1, 90 feet deep; No. 3, 116 feet deep; No. 4, 204 feet deep. The No. 4 shaft is used solely for pumping and the water which formerly gave considerable trouble is now easily controlled by one pump discharging 800 gallons a minute. The mine is worked at 3 levels, at 70, 102, and 132 feet, which are cut together at many places. The ground is mined cheaply, as it breaks easily yet requires very little timbering, and only a very small quantity of the dirt hoisted goes to the dump.

The H. L. & S. Mining Co. sunk a 140-foot shaft and erected a 150-ton mill, which was put in operation in October, 1913. The dirt proved rich and the recovery of concentrates was large considering the length of time the mill was running. Another shaft has been started and the power used has been changed from steam to electric. The Lawton Mining Co.'s lease, which is on the Eastern Lead & Zinc Co.'s land, just west of the H. L. & S. mine, was drilled. Two shafts were sunk 140 feet to the ore body, and the erection of a 250-ton electrically driven mill was commenced. Other leases of the Eastern Lead & Zinc Co. are being developed by J. A. Magoon, L. C. Church, and S. H. Davis.

On the Ball land to the south and east of the present producing mines, 12 drill holes were sunk by the John Hall Mining Co. A 160-foot shaft was also sunk, disclosing a good body of ore between the 130-foot and the 148-foot levels. The concentrating plant was not ready for operation until January, 1914, so that no production was reported. Other operators on the Ball land are the A. J. Young Mining Co., Jeff & Mutt Mining Co., C. H. Staats & Co., and George Ball. The completion of two concentrating plants at Lawton and the very probable erection of others will probably increase the output of sphalerite for 1914.

Galena district.—The production of lead concentrates in the Galena district in 1913 was 3,043 tons, valued at $154,761, as compared with 2,870 tons, valued at $151,661 in 1912. The shipments of zinc concentrates (all of which was sphalerite except 198 tons) were 16,538 tons, a decrease of 2,751 tons. Owing to the much lower prices paid for the smaller output in 1913, the total value of the zinc concentrates was $263,747 less than it was in 1912. There was an increase of 73 tons in the quantity of zinc carbonate and silicate, but the sales of lead carbonate declined from 33 tons in 1912 to 2 tons in 1913. The metal content of the lead concentrates was 2,380 tons in 1913, compared with 2,241 tons in 1912.

The percentage of lead concentrates in crude ore increased slightly, but the metal content in the lead concentrates showed a small decrease. There was the usual large percentage of output made by the small operators who either sell the "dirt" to chatters or mill it at custom concentrating plants. The production from blanket ground was less than in 1912, and some sphalerite concentrates recovered in 1913 were not shipped. The reduced production merely reflects the usual result of the low prices paid for sphalerite in the latter part of the year, for had prices kept up the production would have been equal to that of 1912.

The Diplomat mine on the Galena Lead & Zinc Co.'s land was the largest single producer of both lead and zinc concentrates in Kansas in 1913, though its output was considerably less than in 1912. The quantity of sphalerite concentrates sold was greater than that from the Hartford mine, though the value was less. The concentrating plant at the Diplomat has a rated capacity of 200 tons per 10-hour shift and the mill, hoists, and drills are operated by electric power. Two 100-foot shafts were used to hoist ore from the sheet ground mined during the greater part of the year. The company drilled 7 holes on the northwest corner of their lease and located an ore body between 42 and 56 feet. Two shafts were sunk to this ore and the dirt, which is much richer than that mined at the lower levels, was hauled to the mill for treatment. The production of sphalerite from the Hartford mine on the Empire Zinc Co.'s land increased considerably, and as the zinc content of the concentrates averaged over 62 per cent the value of the zinc concentrates was larger than from any other mine in Kansas. The dirt, which carries no galena, was milled at a 300-ton electrically equipped concentrating plant. During the year a large amount of drilling was done which is stated to have shown extensive bodies of good ore at much lower levels than that which is being mined. The main shaft was sunk to the depth of 270 feet, making it the deepest shaft in the Galena district. Some ore was extracted from the 270-foot level, but most of the production

was derived from ore hoisted from the 168 and 235 foot levels. The ore reserve is said to be sufficiently great to insure profitable operation for several years.

The production from the Lockport Mining Co. leases on the Arthur, Brinkerhoff, Cooper, and Hoosier lands was small, but the output from the Windsor lease was much larger than in 1912. The Windsor mill was operated by the Lockport Mining Co. on custom ores mined by various lessees by means of shafts varying from 10 to 80 feet in depth.

The Illinois Lead & Zinc Co. land produced more sphalerite in 1913 than in 1912. The ore carries very little galena but the quantity recovered increased in 1913. The most productive lease was that of the Peacock-Galena Mining Co., which has three shafts (the deepest of which is 90 feet), and a 150-ton concentrating plant. Five shafts were operated on the Edna Lead & Zinc Co.'s lease by various lessees during a portion of the year and the ore mined was milled at a 100-ton concentrating plant. The lease of the Boston Land & Mining Co. on Illinois land was worked very little in 1913.

The old Southside, Riddle, and Cornwall tracts were leased by the Playter Mining Co., of Kansas, to 17 lessees who mined at levels varying from 50 to 156 feet. The aggregate production of lead and zinc concentrates was large. There were two mills operated on the land, the Beacon of 200 tons capacity and the Chase of 60 tons, but a large portion of the dirt was sold in the rough to C. W. Squire and G. C. Monlux. Development work at the lower levels was satisfactory, indicating that the usual output of ore can be expected from the land in 1914.

The Edith T. mill of 150 tons capacity was operated steadily on ore from the Latawanna land, and the production compared favorably with that of 1912. The productive leases on the Murphy Mining & Realty Co.'s land were Phelps & Co., E. H. Stearns, and the Gussie Moore (Elinita) mine and 150 ton mill, which was operated by Rohrbaugh Bros. The shaft at the Gussie Moore was sunk to the 170-foot level and improvements were made to the mill. The production from the leases on the Murphy land included zinc silicate as well as sphalerite. Lessees of the Empire Mining Co. made a good output from shafts not exceeding 80 feet in depth, the ore being milled at the 100-ton electrically driven concentrating plant on the land.

The production of the Clermont Mining Co., which is mining in sheet or blanket ground 3 miles south of Galena, was slightly larger than in 1912. The mill at the property is of 150 tons capacity, and the recovery of concentrates from ore treated is high for "sheet ground."

The Galena Zinc Mining Co.'s mine and 150-ton mill were operated until October, 1913, when the mine was closed down and the mill removed.

The Empire Mining Co. operated the old Battlefield mine and 250-ton mill and produced a good output of sphalerite and some galena. The shaft at this mine is 110 feet deep. Seven shafts were operated on the land of the Glick Land & Mining Co. Most of the ore milled at the Scarlet Kid 100-ton concentrating plant on this lease, which is owned by F. S. Cook, came from the 90-foot levels, but a considerable production of galena was made from levels reached by

shafts 30 to 50 feet deep. The producing leases were the Scarlet Kid, Quick Eight, Pepper & McDaniel, Fayetteville, and Hatfield.

The Black Hills land west of Galena, owned by the Kansas-Missouri Land Mining Co., was worked by several lessees, including F. L. Stone, who operated a 100-ton concentrating plant which was run on ore mined by Lunsford & Young, the Bumblebee Mining Co., the Doughball Mining Co., and other lessees.

Most of the production of the Connor land came from sublessees of W. P. Clement, and the only production on the Bonanza Lead & Zinc Co.'s land was reported by the Casco Zinc Co.

The Durston Mining Co. leased the Luscombe & McElroy land in 1913 and after drilling the property moved their 300-ton mill from Carthage to the ground. The plant was not ready for operation until the spring of 1914.

There was a large quantity of rough ore sold by various lessees in 1913. Much of this ore was purchased by C. W. Squire, G. C. Monlux, McKinney & Co., and Sterling Robinson. The mills operated by these ore buyers produced a large portion of the blende concentrates shipped from the district.

About 1,000 tons of rich ore was mined by Scott & Quigg from the Templar Mining Co.'s land but it was not milled in 1913. Other producers of either lead or zinc concentrates in 1913 were the Electric Light Plant Mining Co., J. M. Pollard (Brown lots), New Century Zinc & Lead Co., Kennedy & Capps, Land & Cooley, Merchants' Mining Co., and Williams & Robeson, and by lessees of J. K. Williams, Wyandotte Lead & Zinc Co., and Ryan & Moeller.

KENTUCKY.

By J. P. Dunlop.

PRODUCTION.

Lead and zinc deposits are found in both central and western Kentucky. None of the mines in Franklin, Mercer, Scott, Owen, or Henry counties, in the central districts, reported any lead or zinc concentrates shipped in 1913. The mines in the fluorspar region of western Kentucky are chiefly in Crittenden, Caldwell, and Livingston counties and form a continuation of the southern Illinois lead and zinc region. Considerable quantities of galena ores have been produced in former years, but at the present time lead is obtained solely as a by-product in the recovery and concentration of fluorspar, which is the principal economic mineral. The galena recovered is argentiferous, the silver content varying from a very small quantity to over 3 ounces per ton, but no recovery of this silver content has been reported by the smelters during the last three years. The lead concentrate shipped in any one year from Kentucky do not necessarily represent the actual recovery of lead from fluorspar mined in that year, for being merely accessory to the fluorspar and produced in small quantities, it is frequently held until a considerable quantity has accumulated or until lead prices are high.

The production of lead, zinc, and silver in Kentucky in 1913 is shown in the following table:

Production of lead and zinc in Kentucky in 1913 and 1912, in short tons.

Year.	Ores.					
	Lead concentrates (galena).		Zinc concentrates.			
			Sphalerite.		Zinc carbonate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1913	40	$1,422	198	$5,206	696	$13,811
1912	151	6,827	498	25,391	750	16,000

Year.	Metal content.			
	Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.
1913	22	$1,936	327	$36,624
1912	106	9,540	491	67,758

The quantity of zinc concentrates sold decreased from 1,243 tons in 1912 to 894 tons in 1913. The zinc concentrates sold comprised 198 tons of sphalerite of good grade and 696 tons of zinc carbonate, averaging 38.4 per cent metal content. The estimated recoverable spelter content was 491 tons, valued at $67,758.

The shipments of galena concentrates reported in 1913 were 40 tons, valued at $1,422, compared with 151 tons, valued at $6,827, in 1912. On account of part of the concentrates being low grade, the average lead content was only 55 per cent, compared with 70.2 per cent in 1912. The recoverable metallic content of the galena in 1913 was 22 tons, valued at $1,936. There were no large shippers of lead concentrates in Kentucky in 1913, the output being small lots sold by the Pigmy Mining Co., Kentucky Fluorspar Co., and the Sanders Ore Separating Co., from the Larue mines. The Kentucky Fluorspar Co., at Marion, purchased a small quantity of lead from the Eagle Fluorspar Co. and did not ship all the galena concentrates it produced in 1913. The Roberts Fluorspar Co., which mined fluorspar carrying 2 per cent in lead by means of a 300-foot shaft, also reported some unsold galena. The Pigmy Mining Co., of Mexico, Ky., sunk a 150-foot shaft and marketed some low-grade galena concentrates. The Eclipse Mining Co. operated the Commodore mine in the Marion district by means of a 265-foot shaft. The ore recovered was treated at a concentrating plant containing 3 jigs and a slime table, which has a capacity of about 50 tons per 10-hour shift. The concentrates recovered were sphalerite, averaging 54 to 55 per cent zinc content and galena having a lead content of almost 74 per cent. All the production of sphalerite from Kentucky was shipped by the Eclipse Mining Co., but none of the galena concentrates recovered were shipped in 1913.

The largest shipper of zinc carbonate concentrates was the United Mining Co. operating the Mann mine near Lola, which was taken over from the Langenbach Mining Co. The shaft at the Mann mine is

150 feet deep and the ore is cleaned by means of a log washer. Only about 80 per cent of the production in 1913 was sold.

The Sanders Ore Separating Co. recovered some zinc carbonate ore from the land of the Marion Mineral Co. and a small shipment was also made by the Ohio Valley Fluorspar Mining Co. near Mexico, Ky.

No lead or zinc ore was shipped from the Tabb mine of the Hoosier Mining Co., though some fluorspar was shipped.

MICHIGAN.

By B. S. Butler.

PRODUCTION.

In 1913 the mines of Michigan produced 135,853,409 pounds of copper, valued at $21,057,278, and 295,173 fine ounces of silver, valued at $178,285, a total value in copper and silver of $21,235,563. This is a decrease of $15,082,273 in value, or about 42 per cent, from the production of 1912. The decrease in the metal output was due to labor troubles in the district. A strike of miners was called July 23, and for the remainder of the year the output of all the mines was greatly reduced and several were closed. For 1912 the average price of copper per pound was $0.165, and for 1913 it was $0.155. The average price of silver for 1912 was $0.615 per fine ounce, and for 1913 it was $0.604. Owing to the decrease in the price of copper there was a decrease from $3.15 in 1912 to $3 in 1913 in the average value per ton of rock treated.

The smelter production, or the output of refined copper, for 1913 was 155,715,286 pounds as compared with 231,112,228 pounds in 1912. The difference between the mine and the smelter production is due to the fact that the quantity of mineral produced is not the same as the quantity smelted. A company may produce either more or less mineral than it smelts during the year.

The following table shows the average values in copper and silver of rock treated in 1912 and 1913:

Value of silver and copper product of Michigan mines in 1912 and 1913.

Year.	Silver.	Copper.		Combined silver and copper, total value.
		Value.	Value per ton of rock.	
1912	$324,999	$35,992,837	$3.15	$36,317,836
1913	178,285	21,057,278	3.00	21,235,563
Decrease	146,714	14,935,559	.15	15,082,273

The entire Michigan output of copper and silver is from the Keweenaw district. Both metals occur native in lodes remarkable for their great extent and uniformity. These lodes may be divided into two general classes: The amygdaloid, in which the metals occur together with gangue minerals, epidote, calcite, zeolites, etc., in the cellular portions of lava flows, and the conglomerate, in which the metals and

gangue minerals cement and to some extent replace the pebbles forming the conglomerate. Native copper and copper minerals occur in fissures in the district, but the present output from this type of deposit is of little importance. The "rock" [1] is of low grade and requires milling, which produces "mineral" carrying an average of about 65 per cent copper. A small quantity of "barrel" and "mass" copper is sorted at the mines and sent direct to the smelters.

In 1913 there were 7,016,370 short tons of rock milled, which yielded 214,153,571 pounds of "mineral" and 135,853,409 pounds of copper.[2]

The average recovery of refined copper per ton of rock milled in 1913 was 19.4 pounds, as compared with 19.1 pounds in 1912.

There were 295,173 ounces of silver derived from the electrolytic treatment of 36,997,000 pounds of copper. This electrolytic copper was recovered from approximately 1,770,000 tons of rock, an average of 0.166 fine ounce of silver per ton of rock.

The following table shows the production of metal, "mineral," and "rock" in Michigan for 1912 and 1913:

Production of silver, copper, "mineral," and "rock" in Michigan in 1912 and 1913.

Year.	Silver.	Copper.			"Mineral."		"Rock."
		Quantity.	Yield per ton of rock.		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
1912	528,453	218,138,408	19.1	0.96	339,756,812	64.24	11,411,941
1913	295,173	135,853,409	19.4	0.97	214,153,571	63.44	7,016,370
Increase(+)or decrease(−)	−233,280	−82,284,999	+0.3	+0.01	−125,603,241	−0.80	−4,395,571

The following table shows the relative productive importance of the amygdaloid and the conglomerate rock in 1912 and 1913. The proportion of copper derived from conglomerate dropped from 30 per cent in 1911 to 27.3 per cent in 1912 and increased to 29.7 per cent in 1913. The yield per ton of conglomerate "rock" was 28.1 pounds in 1911, 27.7 pounds in 1912, and 30.1 pounds in 1913.

In 1907 conglomerate "rock" produced 41.4 per cent of the output, with a yield of 33.9 pounds per ton.

In 1913 amygdaloid "rock" yielded 16.8 pounds of copper per ton, as compared with 17.1 pounds per ton in 1912.

[1] Some of the terms used to designate the different materials entering into the mining industry differ for the Lake district from those employed in any other part of the country. Ore is known as "rock" or "copper ground" (if unmined); the product of concentration is known as "mineral;" the term "ore" is used to designate the copper minerals (arsenides, sulphides, etc.) that occur to a limited extent in the district. Large bodies of native copper are known as "mass" and smaller ones are designated as "barrel work." In this report the local terms will be used, as it does not seem desirable to employ the more usual terms to the exclusion of the local, while a mixture of the two is confusing.

[2] The figures are based on the actual recovery of copper from "mineral" smelted and the estimated recovery from "mineral" that was not smelted during 1913.

Production of "rock" and "mineral" and yield in silver and copper in Michigan in 1912 and 1913, by kinds of rock.

	1912		1913	
	Amygdaloid "rock."	Conglomerate "rock."	Amygdaloid "rock."	Conglomerate "rock."
Silver:				
Fine ounces	528,453		295,173	
Average yield per short ton of rock, ounce	0.05		0.04	
Copper:				
Pounds	158,553,428	59,584,980	95,519,061	40,334,348
Per cent of total	72.7	27.3	70.3	29.7
Average yield per short ton of rock, pounds	17.1	27.7	16.8	30.1
Average yield, per cent	0.85	1.38	0.84	1.50
"Mineral":				
Pounds	235,026,944	104,729,868	214,153,571	
Per cent of total	69.1	30.9		
Average yield in copper, per cent	67.5	56.9	63.4	
"Rock":				
Short tons	9,264,816	2,147,125	5,674,312	1,342,058
Per cent of total	81.2	18.8	81.0	19.0

Three counties, Houghton, Keweenaw, and Ontonagon, contributed to the output of copper and silver in 1913. The following table shows the relative importance of these counties in output of copper and silver for 1912 and 1913:

Production of silver and copper in Michigan for 1912 and 1913, by counties.

1912.

County.	Silver.	Copper.		"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."	Quantity.	Yield.	
	Fine oz.	*Pounds.*	*Pounds. Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
Houghton	475,453	179,476,295	19.6 0.98	284,218,905	63.1	9,145,601
Keweenaw	53,000	33,976,822	19.2 .96	48,633,935	69.9	1,772,817
Ontonagon		4,685,291	9.5 .47	6,903,972	67.9	493,523
Total	528,453	218,138,408		339,756,812		11,411,941
Average			19.1 .96		64.2	

1913.

Houghton	253,030	113,129,113	19.6 0.98	180,670,976	62.6	5,768,454
Keweenaw	42,143	19,090,109	19.4 .97	28,268,525	67.5	984,205
Ontonagon		3,634,187	13.8 .69	5,214,070	69.7	263,711
Total	295,173	135,853,409		214,153,571		7,016,370
Average			19.4 .97		63.4	

REVIEW BY COUNTIES.[1]

In the following reviews of the operations at the individual mines of the district during 1913 the statements concerning the quantity, character, and tenor of "rock" developed, the quantity of rock stamped, the copper recovered per short ton of rock stamped, and

[1] Those desiring more details concerning individual properties are referred to a report by Reginald E. Hore, Mineral resources of Michigan: Michigan Geol. and Biol. Survey, pp. 15–115, 1911. This report contains a description of the geology, ore deposits, methods of extraction, and treatment of ores, of developments at individual properties, of cost of production, etc., and gives references to the more important publications concerning the copper industry of the district.

the cost of production are based on the published reports of the companies. In the few cases in which reports are not published a general statement of the character of operations is made from the best information available.

A general strike of miners was called in the district July 23, 1913, and for the remainder of the year conditions were abnormal. The operations at all the mines were greatly curtailed and many of them were idle. Under such conditions the cost of producing copper was greatly increased and the costs in 1913 can not be considered as representative of the normal costs for the individual properties or for the district, as is readily seen by comparison with preceding years.

HOUGHTON COUNTY.

In 1913 the mines of Houghton County produced 113,129,113 pounds of copper and 253,030 ounces of silver, or 83.3 per cent of the copper and 85.7 per cent of the silver output of Michigan. The county occupies the central portion of the copper belt and contains 15 of the 22 mines that contributed in 1913 to the copper output and 5 of the 7 mines that produced silver.

The details of the production in 1912 and 1913 are shown in the following table:

Production of "rock" and "mineral" and average yield in silver and copper in Houghton County in 1912 and 1913, by kinds of rock.

	Amygdaloid rock.		Conglomerate rock.		Total and average.	
	1912	1913	1912	1913	1912	1913
Silver:						
Fine ounces	[a] 475,453	[a] 253,030	.....	.....	475,453	253,030
Copper:						
Pounds	119,891,315	72,794,765	59,584,980	40,334,348	179,476,295	113,129,113
Per cent, county total	66.8	64.3	33.2	35.7	100.0	100.0
Average yield per ton of rock, in pounds	15.9	16.4	27.8	30.1	19.6	19.6
Average yield..per cent..	0.79	0.82	1.39	1.50	0.98	0.98
"Mineral":						
Pounds	179,489,037	[b]180,670,976	104,729,868	(b)	284,218,905	180,670,976
Average yield..per cent..	66.8	.....	56.9	.....	63.1	62.6
"Rock":						
Short tons	6,998,476	4,426,396	2,147,125	1,342,058	9,145,601	5,768,454
Per cent, county total	76.5	76.7	23.5	23.3	100.0	100.0

[a] Silver from conglomerate and from amygdaloid rock has not been separated. A large percentage, however, was derived from amygdaloid rock.
[b] Amygdaloid and conglomerate combined.

The output of the county shows a decrease of 66,347,182 pounds of copper and of 222,423 fine ounces of silver for 1913.

Calumet & Hecla.—The Calumet & Hecla Mining Co. has been one of the most successful copper mines in the world. In the yield of copper and dividends paid it ranks first among the copper mines of the country. To the close of 1913 the company had distributed $123,250,000 in dividends.

The company's ground contains three copper-bearing lodes, the "Calumet" conglomerate, the Osceola amygdaloid, and the "Kearsarge" amygdaloid. A large percentage of the production in the past has come from the conglomerate lode, but with the decrease in copper

content of this lode and its approaching exhaustion the mining from the amygdaloid lodes has increased.

The company's annual report shows the details of operation for 1913 as follows:

During 1913 there were 2,035,625 short tons of rock stamped, yielding 45,016,890 pounds of copper, or an average of 22.11 pounds of copper per ton of "rock." This compares with a yield of 24.18 pounds for 1912 and of 25.47 pounds for 1911. The total cost per pound of copper was 14.25 cents for 1913, as compared with 9.86 cents for 1912.

The conglomerate is opened for a distance of nearly 2 miles along its strike by 10 inclined shafts and 1 vertical shaft. The inclined shafts vary in depth on the dip of the lode from 6,102 to nearly 8,000 feet. The Red Jacket vertical shaft has a depth of 4.900 feet. The lode in the "Five Forties" tract, extending north from the company's main holdings, is developed by a slope shaft from the fifty-seventh level. The rock from this shaft is hoisted to the surface through the Red Jacket shaft.

In 1913 the conglomerate lode produced 1,175,259 tons of "rock," yielding 32,731,768 pounds of copper, or an average of 27.85 pounds per ton of rock. This compares with 30.38 pounds for 1911 and 29.73 pounds for 1912.

The cost of producing copper from the conglomerate lode in 1913 was 12.67 cents per pound, as compared with 8.87 cents in 1912 and and with 8.25 cents in 1911.

The Osceola lode is developed by six shafts varying in depth from 1,460 to 3,232 feet. The lode has an average width of from 30 to 35 feet, though at some points it is much wider. The mineralization is confined principally to the hanging and the foot walls. The lode is opened by drift stopes along the hanging wall, where the mineralization is rather uniform. Crosscuts are extended to the footwall, where the mineralization is far less regular. During 1913 this lode produced 842,162 tons of "rock," yielding 12,051,238 pounds of copper, or 14.31 pounds per ton of "rock." This compares with a yield of 15.08 pounds for 1912 and of 15.89 pounds for 1911. The average cost per pound of copper from this lode for 1913 was 12.62 cents, as compared with 10.36 cents for 1912 and with 9.95 cents for 1911.

The Kearsarge lode is opened by three shafts, varying in depth from 1,350 to 2,291 feet. Development on this lode in Calumet & Hecla ground has not been encouraging, though the lode has proved very productive farther north. During the year 1913, 18,203 tons of "rock" from this lode yielded 233,915 pounds of copper.

The recrushing plant treated 388,164 tons of coarse tailings containing an average of 11.92 pounds of copper per ton; 1,529,097 pounds of copper was recovered, or an average of 3.94 pounds per ton of tailings treated. The cost per pound of copper recovered, exclusive of smelting and selling, was 5.87 cents.

The new recrushing plant was partially completed during the year and the installation of a dredge to recover the old tailings from Torch Lake was started.

The company reports that a leaching process has been developed that can be applied to a large proportion of the waste tailings from the recrushing plant.

Tamarack.—The Tamarack ground lies northwest of the Calumet & Hecla, and its operations are conducted on the underlays of the "Calumet" conglomerate and the Osceola amygdaloid. Both lodes enter the property at considerable depth and are reached by vertical shafts, the different levels being connected with these shafts by crosscuts. The property is opened by five shafts, varying in depth from 3,409 feet (No. 1) to 5,308.5 feet (No. 5), the latter having the distinction of being the deepest shaft in the world.

The company, although at a disadvantage on account of the great depth of the mine and the consequent high mining costs, has made a good record in dividends, which from 1888 to 1907 aggregated $9,420,000. Since the decline in the price of copper in 1907, however, the company has been unable to show a profit until 1912, when relatively high prices again prevailed and copper was produced at a profit.

The average cost per pound of production during the last three years has been 15.56 cents for 1911, 13.15 cents for 1912, and 16.60 cents for 1913.

Shaft No. 1 is used for handling the water in the southern portion of the mine, thus leaving the neighboring shafts free for the hoisting of ore.

At No. 2 shaft very little drifting was done on the conglomerate lode, and over half the output was recovered from ground previously abandoned. The openings on the Osceola amygdaloid lode were made on the footwall side, and some of the best ground came from stopes in this portion of the lode.

At No. 3 shaft all openings showed fair copper values.

At No. 5 shaft a limited amount of opening on sublevel 38½ showed ground of average value.

During the year 227,563 tons of "rock" were stamped, yielding 6,206,295 pounds of "mineral" and 4,168,743 pounds of copper, or 18.3 pounds of refined copper per ton of "rock" stamped. This compares with a yield of 21.1 pounds in 1910, 19.1 pounds in 1911, and 18.8 pounds in 1912. The mine was closed at the time of the strike, and operations were not resumed during the year.

Osceola.—During 1913 the Osceola Co. operated the three branches—the Osceola, the South Kearsarge, and the North Kearsarge. Since 1878 this company has distributed dividends to the amount of $11,987,375.

The Osceola lies directly south of the Calumet & Hecla, and is worked on the Osceola amygdaloid. The property contains the Calumet & Hecla lode, but the only portion of this in Osceola ground that has been shown to carry copper in paying quantities was worked out in the early days of the mine.

A total of 177,908 tons of "rock" was produced, yielding 1,952,010 pounds of copper, or an average of 10.97 pounds per ton, at a cost of 20.79 cents per pound.

The North Kearsarge lies north of the Wolverine, and is worked on the Kearsarge lode. No. 1 shaft has a depth of 3,873 feet, No. 3 shaft has a depth of 3,301 feet, and No. 4 shaft has a depth of 1,449 feet. A total of 2,151 feet of opening was accomplished on this branch during the year. This branch produced 300,903 tons of "rock,"

yielding 4,369,000 pounds of copper, or an average of 14.52 pounds per ton, at a cost of 12.46 cents per pound.

The South Kearsarge lies south of the Wolverine and east of the Centennial on the Kearsarge lode. No. 1 shaft has a depth of 2,820 feet, and No. 2 shaft has a depth of 1,992 feet. No new openings were made at this division during 1913. Nearly two-thirds of the tonnage was mined from the footwall.

This branch produced 256,233 tons of "rock," yielding 5,004,000 pounds of copper, or an average of 19.53 pounds per ton, at a cost of 8.11 cents per pound.

In 1913 the company treated 735,044 tons of "rock," producing 14,945,645 pounds of "mineral," or 11,325,010 pounds of copper, an average yield of 15.4 pounds of refined copper per ton of "rock." This compares with a yield of 14.8 pounds in 1911 and 1912. The total cost of refined copper per pound was 12.30 cents for 1913, as compared with 10.36 cents in 1912.

Centennial.—The Centennial ground lies north of the Calumet & Hecla and west of the South Kearsarge and the Wolverine. It contains the Calumet & Hecla, the Osceola, and the Kearsarge lodes, the last being the only one of proved value in the property, and to this lode operations are at present confined.

At the close of 1913 the depth of No. 1 shaft was 3,821 feet. No work was done in the vicinity of this shaft during 1913. Shaft No. 2 had a depth of 4,293 feet at the close of the year. A total of 1,326 feet of development was accomplished at this shaft. The openings to the north were up to the average quality.

Rock to the amount of 85,443 tons was stamped during the year, producing 2,324,040 pounds of "mineral" and 1,612,262 pounds of refined copper, or 18.87 pounds refined copper per ton of rock stamped. The average cost of refined copper per pound was 13.38 cents, as compared with 13.46 cents for 1912.

Wolverine.—The Wolverine is located between the North and the South Kearsarge branches of the Osceola Co. Its operations are on the "Kearsarge" amygdaloid, though the West lode, parallel with the Kearsarge lode and about 80 feet to the west, has been opened to a small extent. The mine has the distinction of having the richest amygdaloid and, next to the "Calumet" conglomerate, the richest rock mined in the district. The Kearsarge lode is opened by five shafts, numbered from 1 to 5, from north to south. No. 1 is abandoned; No. 2, bottomed at the boundary at a depth of 1,700 feet, is used for handling men and supplies; No. 3 has attained a depth of 3,995 feet and can be sunk to a depth of 4,300 feet before reaching the boundary; No. 4 has a depth of 3,872 feet; No. 5 was sunk to a depth of 631 feet on the Osceola lode prior to June, 1913. The operations on the Osceola lode have thus far proved disappointing. The Kearsarge lode in the Wolverine ground shows great uniformity of mineralization and is opened for the full length. In the upper levels the rock averaged from 16 to 18 pounds per ton, but as the lower levels were opened it showed marked improvement, the average for the fiscal year ending June 30, 1913, being 21.49 pounds per ton.

During the fiscal year ending June 30, 1913, 388,502 tons of "rock" were stamped, producing 10,782,405 pounds of "mineral," yielding 8,350,312 pounds of copper, or 21.49 pounds of refined copper per

ton of "rock" stamped. The total cost per pound of refined copper was 8.665 cents.

Franklin.—The Franklin and the Rhode Island, which is controlled by the Franklin, are located southeast of the La Salle. The property carries several lodes, but in the past exploration has been principally on the "Pewabic" amygdaloid and the Allouez or "Albany and Boston" conglomerate.

Drifting on the Pewabic lode revealed about an average proportion of mill rock and poor rock in the upper levels, with the better grade showing near the bottom of the mine.

The exploratory crosscut on the thirty-second level reached the Allouez conglomerate early in 1914. Where cut by the crosscut the lode is well mineralized.

During the year, 123,179 tons of "rock" were stamped, yielding 1,021,440 pounds of copper.

Quincy.—The Quincy mine is situated just north of the east-west arm of Portage Lake. The property is traversed by most of the lodes of the district, but has derived its principal output in the past from the Pewabic lode, with a small quantity from the West lode.

The extent of underground development for the year was 23,611 linear feet. The ground developed was of the same general character as that of the previous year.

Dividends during 1913 to the amount of $412,500 have been paid. The total disbursement of dividends from 1862 to 1913 has been $20,842,500.

During the year 12,184,128 pounds of refined copper was produced.

Isle Royale.—The Isle Royale mine is situated south of the east-west arm of Portage Lake, near Houghton. The property contains several copper-bearing lodes, of which the Isle Royale is the main producer at present. A total of 13,626 feet of opening developed ground of about average value.

During the year 314,679 tons of "rock" was treated, yielding 5,887,000 pounds of mineral and 4,158,548 pounds of copper, or an average of 13.2 pounds of copper per ton. The average cost per pound of copper was 18.81 cents as compared with 11.89 cents in 1912.

Baltic, Champion, and Trimountain.—These three mines are located on the Baltic lode southwest of Houghton and are under the same management, that of the Copper Range Consolidated Co. The Baltic is an exceptionally strong lode, having a stoping width varying from 15 to 80 feet. The lode has produced considerable "mass" copper and also contains veinlets of copper minerals, including chalcocite, bornite, and copper arsenides. These minerals are recovered in the mill, and the arsenides probably account in part for the arsenical character of the Copper Range output.

During 1913 the Baltic operated three shafts with depths of 2,348 feet for No. 2, 2,623 feet for No. 3, and 2,517 feet for No. 4.

Developments during the year showed little change from 1912 in the general character of the rock.

A total of 333,289 tons of "rock" was stamped, producing 13,282,825 pounds of "mineral" yielding 7,736,124 pounds of refined copper, or 23.21 pounds of refined copper per ton of "rock" stamped. The cost per pound of refined copper was 11.91 cents.

The Trimountain is also opened by three shafts, with depths of 2,859 feet for No. 2, 2,361 feet for No. 3, and 2,323 feet for No. 4, at the close of 1913.

Good ground was opened during the year. A total of 229,149 tons of "rock" was stamped, yielding 8,546,070 pounds of "mineral" and 4,990,938 pounds of refined copper, or an average of 21.78 pounds per ton. The average cost per pound of copper was 12.62 cents.

The Champion, controlled jointly by the Copper Range Consolidated Co. and the St. Mary's Mineral Land Co., is opened by four shafts, with depths varying from 2,239 to 2,514 feet, at the close of 1913. The openings made during the year were in good ground.

A total of 421,849 tons of "rock" was stamped, yielding 19,251,470 pounds of "mineral," or 12,080,594 pounds of refined copper, a yield of 28.64 pounds per ton of "rock" stamped. The cost of refined copper per pound was 10.71 cents. The increase in the recovery per ton of rock from 22.5 pounds in 1912 was due in part to the product from the regrinding plant.

Superior.—The superior is located northeast of the Baltic on the Baltic lode. The lode on this property is being opened by two shafts. At the close of 1913 No. 1 shaft had reached a depth of 2,014 feet, and No. 2 a depth of 1,613 feet.

At No. 1 shaft developments on the west lode showed good copper rock on the seventeenth, eighteenth, nineteenth, and twentieth levels south of the shaft; but development to the north has failed to show anything of value except on the twentieth level near the shaft.

During the year 130,826 tons of "rock" were stamped, producing 2,992,765 pounds of copper, or 22.87 pounds per ton of "rock" stamped. The cost of copper a pound was 12.86 cents.

Winona.—Drifting to the south of No. 4 shaft, particularly on the sixth, eleventh, thirteenth, and fifteenth levels, has shown ground better than the average. There were stamped 120,806 tons of "rock" which yielded 2,467,460 pounds of "mineral" and 1,448,737 pounds of refined copper, an average of 11.99 pounds of refined copper per ton of "rock" stamped.

Other companies.—There were other companies that were active in development work during the first half of the year, but this development was largely suspended after the labor strike was called in July.

KEWEENAW COUNTY.

In 1913 Keweenaw County produced 19,090,109 pounds of copper and 42,143 fine ounces of silver, being 14.1 per cent of the copper and 14.3 per cent of the silver produced in the Lake district. The county occupies the northern portion of the copper belt. This section of the belt produced considerable copper in the early days of Lake mining but of late years has furnished a comparatively small percentage of the total output. Developments, however, indicate that the county should increase in importance in the future.

The following table shows the production of "rock" and "mineral" and the average yield in silver and copper in Keweenaw County in 1912 and 1913:

Production of "rock" and "mineral" and average yield in silver and copper in Keweenaw County in 1912 and 1913.

Year.	Silver.	Copper.			"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
1912	53,000	33,976,822	19.2	0.96	48,633,935	69.8	1,772,817
1913	42,143	19,090,109	19.4	.97	28,268,525	67.5	984,205

From this table it is seen that in 1913 there was a decrease in the quantity of "rock" treated, and an increase in the quantity of copper recovered per ton of "rock."

Ahmeek.— The Ahmeek mine, lying north and east of the Allouez, is located on the Kearsarge lode. The lode is opened by four shafts. No. 1 has a depth of 2,506 feet; No. 2, a depth of 2,693 feet; No. 3, 2,144 feet; and No. 4, 2,158 feet. The principal openings during the year were at shafts Nos. 1 and 2, where the ground developed was of about average grade.

During the year construction of the 4-stamp addition to the mill was in progress. A total of 383,749 tons of "rock" was stamped, yielding 13,742,141 pounds of "mineral," and 9,220,874 pounds of refined copper, or 24.0 pounds of refined copper per ton of "rock." The total cost per pound of refined copper was 13.30 cents.

Allouez.—The Allouez mine is north of the North Kearsarge, and, as in recent years, operations were confined to the Kearsarge lode. As this lode does not outcrop on Allouez property, the shafts were started in the hanging wall at a steep angle and flattened to the dip of the copper-bearing bed just before reaching it. This plan avoids the expense of long crosscuts necessitated by vertical shafts.

At the close of the year No. 1 shaft had a depth of 3,499 feet, and No. 2 shaft had a depth of 3,407 feet. A total of 4,399 feet of openings at the two shafts developed ground of average grade.

A total of 236,663 tons of "rock" was stamped during the year, yielding 6,640,000 pounds of "mineral," or 4,091,129 pounds of refined copper, an average of 17.29 pounds of refined copper per ton of "rock." The total cost per pound of refined copper was 12.09 cents.

Mohawk.—The Mohawk mine, lying east of the Ahmeek, carries the outcrop of the Kearsarge lode for more than a mile and also contains several cross fissures carrying arsenides of copper, which have been mined to a considerable extent in the past. Operations were conducted through five shafts.

A total of 366,458 tons of "rock" was stamped, yielding 8,018,000 pounds of "mineral," or 5,778,235 pounds of copper. The total cost per pound of refined copper was 13.22 cents.

There were several companies doing development work during the first half of the year, but this was discontinued for the most part at the time of the strike.

ONTONAGON COUNTY.

In 1913 Ontonagon County produced 3,634,187 pounds, or 2.7 per cent of the copper produced in the Lake district. Ontonagon County contains the southwestern portion of the copper belt. This portion has not been so thoroughly developed as the others, and consequently the geology is less understood than in the more northern counties. So far as developed the lodes are more bunchy than to the north and have produced a relatively high percentage of mass copper. The production of 1913 was derived wholly from amygdaloid rock.

The following table shows the production of the county in 1912 and 1913:

Production of "rock" and "mineral" and average yield in silver and copper in Ontonagon County in 1912 and 1913.

Year.	Silver.	Copper.			"Mineral."		"Rock."
		Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Short tons.*
1912	.....	4,685,291	9.4	0.47	6,903,972	67.8	493,523
1913	.....	3,634,187	13.8	.69	5,214,070	69.7	263,711

The production for 1913 shows a slight decrease from that of 1912. The developments in the county for the last few years have been very encouraging, and it will probably show an increase in production in the future.

Mass.—The Mass mine, adjoining the Adventure on the southwest, carries six known copper-bearing amygdaloid lodes, the Knowlton, the Mass, the North Butler, the Butler, the Ogima, and the Evergreen. In addition, the position of the property makes it probable that the newly discovered lodes in this part of the district may be present in the Mass ground. The main developments for the year were from "B" and "C" shafts on the Butler and Evergreen lodes, and continued to show as satisfactory conditions with respect to copper values as in previous years.

A total of 78,250 tons of "rock" was stamped, yielding 1,773,810 pounds of "mineral" and 1,213,545 pounds of refined copper, an average of 15.51 pounds of refined copper per ton of "rock" stamped.

Victoria.—The Victoria is the most southwesterly of the Lake mines that have made important production. The first attempts at copper mining in the district are said to have been made at this locality, though its recent period of productiveness began in 1906. The present production is from the Forest lode.

A total of 52,435 feet of opening was accomplished in the mine during the year, mainly from No. 2 shaft. "Rock" amounting to 137,163 tons was stamped, yielding 2,273,890 pounds of "mineral" and 1,428,693 pounds of refined copper.

The Lake mine was a producer during the year, and development was carried on by other companies, especially during the first half of the year or until the miners' strike.

MISSOURI.

By J. P. Dunlop.

PRODUCTION.

VALUE.

The value of the mine output of silver, copper, lead, and zinc in Missouri in 1913 was $29,604,890, compared with $34,914,761 in 1912. The value of the copper production showed an increase and the value of the lead decreased only about $430,000, so that the large decrease in the value in 1913 was caused mainly by the smaller output and much lower average price of spelter compared with 1912. The recoverable lead content of Missouri lead concentrates sold in 1913 was equal to 40 per cent of the smelter production of primary lead in the United States derived from domestic ores, and the recoverable spelter content from Missouri zinc concentrates sold in 1913 was 37 per cent of the primary spelter produced by smelters from domestic ores in 1913.

SILVER AND COPPER.

The following table shows the production of silver and copper in Missouri in the years 1910 to 1913, inclusive:

Mine production of silver and copper in Missouri, 1910–1913.

Year.	Copper.		Silver.		Lead concentrates, silver-bearing.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Fine ozs.*		*Short tons.*
1910	94,452	$11,955	33,096	$17,872	35,002
1911	640,411	80,051	49,867	26,430	51,109
1912	440,725	72,719	35,438	21,794	31,183
1913	576,204	89,312	35,620	21,514	35,854

For several years prior to 1913 the entire silver production has been derived from refining lead concentrates, but in 1913 a small quantity of silver was obtained from oxidized copper ore shipped by the Cornwall mine of St. Genevieve County.

The quantities given in the fourth column of the foregoing table are those of recovered silver. The silver content of the lead ores is so small that it is disregarded in the assay and sale of the concentrates. For this reason the smelter reports must be relied upon for the silver production. As may be seen by inspection of the table, the quantity of silver produced in any year bears no direct ratio to the quantity of lead concentrates smelted during that year. The reason for this is that the silver content is so small in quantity that the silver bullion is stored and refined in batches. If a series of years be taken into account, the concentrates are seen to average about 1 ounce of silver to the ton. The value is estimated at the average New York price according to the United States Mint.

COPPER.

The production of copper in Missouri in 1913 was 576,204 pounds, valued at $89,312, as compared with 440,725 pounds, valued at $72,719, in 1912. The mines of the North American Lead Co., which produced some copper, as well as nickel and cobalt in the years 1908 and 1909, were idle during 1913. The copper output for 1910, 1911, and 1912 was derived from concentrates recovered in dressing lead ore mined in St. Francois County, in southeastern Missouri. In 1913 there was an increased yield of copper from lead concentrates and in addition a considerable quantity of copper was recovered from copper ore shipped by the Cornwall Copper Mining & Smelting Co.

LEAD AND ZINC.

The production of lead and zinc in Missouri in 1913 is shown in the following table:

Mine production of lead and zinc in Missouri in 1913, by districts, in short tons.

District.	Ore.							
	Lead concentrates.				Zinc concentrates.			
	Galena.		Carbonate.		Sphalerite.		Silicate and carbonate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Southwestern Missouri:								
Alba-Neck City	363	$19,564	.....	.....	16,425	$700,741	116	$1,656
Ash Grove-Everton	15	750	.....	.....	.....	.....	75	1,125
Aurora	56	2,516	13	$381	331	12,332	2,139	46,608
Carl Junction	173	8,895	.....	.....	10,607	440,560	.....	.....
Carthage	15	809	.....	.....	2,391	100,727	52	947
Cave Springs	181	9,218	.....	.....	3,331	144,810	.....	.....
Duenweg-Porto Rico	4,051	202,938	4	123	20,075	824,867	1,991	37,693
Granby	388	19,519	168	5,608	3,234	122,996	10,708	269,133
Joplin	3,963	212,005	106	3,488	42,061	1,775,228	1,457	26,651
Oronogo	1,449	74,069	.....	.....	12,023	478,154	.....	.....
Sarcoxie-Reeds	.....	.....	.....	.....	1,719	71,451	490	10,000
Sherwood-Thoms Station	1,432	75,480	.....	.....	21,700	774,180	.....	.....
Spring City-Beef Branch	1,839	88,597	32	948	2,952	91,178	2,043	42,231
Springfield	56	3,043	.....	.....	650	30,000	.....	.....
Spurgeon	146	6,580	.....	.....	1,671	73,759	1	30
Webb City-Carterville-Prosperity	21,771	1,125,324	.....	.....	77,469	3,173,220	.....	.....
Wentworth and Stotts City	.....	.....	.....	.....	601	24,549	690	14,800
Zincite and Klondike	81	4,187	.....	.....	8,577	341,634	.....	.....
Wetherill and Taney	.....	.....	.....	.....	.....	.....	1,130	19,098
	35,979	1,853,494	323	10,548	225,817	9,180,386	20,892	469,972
Central and Southeastern Missouri	219,511	9,580,893	.....	.....	33	574	639	13,491
State total 1913	255,400	11,434,387	323	10,548	225,850	9,180,960	21,531	483,463
1912	256,477	11,935,535	361	12,823	244,986	12,346,922	22,172	641,881
1911	258,006	12,460,902	234	8,358	217,812	8,680,559	20,119	477,420
1910	247,861	11,286,750	197	6,385	232,341	9,342,139	23,826	561,803
1909	249,151	10,893,024	385	11,124	229,023	9,445,826	28,525	677,213
1908	218,213	8,629,039	664	18,220	198,340	6,800,359	20,601	451,607
1907	193,528	10,535,890	357	11,764	222,347	9,208,465	18,733	427,146

Mine production of lead and zinc in Missouri in 1913, by districts, in short tons[a]—Conta

District.	Metal content.			
	Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.
Southwestern Missouri:				
Alba-Neck City	289	$25,432	8,885	$995,120
Ash Grove-Everton	12	1,056	22	2,464
Aurora	50	4,400	939	105,168
Carl Junction	137	12,056	5,626	630,112
Carthage	12	1,056	1,277	143,024
Cave Springs	146	12,248	1,798	201,376
Duenweg-Porto Rico	3,266	287,408	10,813	1,211,056
Granby	417	36,696	5,472	612,864
Joplin	3,190	280,720	22,769	2,550,128
Orongo	1,145	100,760	6,060	678,720
Sarcoxie-Reeds	.....	.....	1,111	124,432
Sherwood-Thoms Station	1,148	101,024	10,696	1,197,952
Spring City-Beef Branch	1,396	122,848	2,078	232,736
Springfield	46	4,048	371	41,552
Spurgeon	107	9,416	876	98,112
Webb City-Carterville-Prosperity	17,133	1,507,704	40,486	4,534,432
Wentworth and Stotts City	.....	.....	565	63,280
Zincite and Klondike	64	5,632	4,590	514,080
Wetherill and Taney	.....	.....	288	32,256
Total	28,558	2,513,104	124,722	13,968,864
Central and southeastern Missouri	147,558	12,985,104	241	26,992
State total, 1913	176,116	15,498,208	124,963	13,995,856
1912	177,069	15,936,210	136,551	18,844,038
1911	178,868	16,098,120	122,515	13,966,710
1910	161,016	14,169,408	129,589	13,995,612
1909	159,435	13,711,410	130,162	14,057,496
1908	144,459	12,134,556	107,404	10,095,976
1907	138,675	14,699,550	116,752	13,776,736

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in the case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

The total value of the recoverable metallic content of the lead and zinc concentrates produced in Missouri in 1913 was $29,494,064, a decrease of $5,286,184 from that of 1912. The production of lead concentrates in Missouri in 1913 (of which all but 323 tons were galena) was 255,723 short tons, valued at $11,444,935, as compared with an output of 256,838 tons, valued at $11,948,358, in 1912, a decrease of 1,115 tons in quantity and of $503,423 in value. Of this 1913 production of lead concentrates 219,511 tons, valued at $9,580,893, was derived from southeastern and central Missouri, an increase of 708 tons in quantity and a decrease of $268,961 in value. The average metal content of the lead concentrates from these districts was 67.2, as compared with 67.1 in 1912, and the value per ton in 1913 was $43.63, a decrease of $1.38. The quantity of recoverable lead in southeastern and central Missouri concentrates in 1913 amounted to 147,558 tons, a decrease of 645 tons. The output was equal to nearly 34 per cent of the primary lead smelted or refined from domestic ores in the United States in 1913.

Shipments of lead concentrates from southwestern Missouri were 36,302 tons, valued at $1,864,042, as compared with 38,035 tons, valued at $2,098,504, in 1912. The lead carbonate concentrates amounted to only 323 tons, valued at $10,548, a decrease of 38 tons. The quantity of recoverable lead from southwestern Missouri, or the

Joplin region, was 28,558 tons, valued at $2,513,104, a decrease of 1,598 tons. The average metal content of the galena concentrates from southwestern Missouri was 78.8 per cent, and the average price per ton was $51.50, or $3.86 less per ton than in 1912.

The quantity of zinc blende concentrates sold from Missouri mines in 1913 was 225,850 tons, valued at $9,180,960, a decrease of 19,136 tons in quantity and of $3,165,962 in value, when compared with the 1912 figures. All of the blende concentrates except 33 tons was produced in southwestern Missouri. The average price received per ton was $40.70, and the average recoverable zinc content was 57.8 per cent. The average price paid per ton in 1912 was $50.44 and the average recoverable zinc content was 58.4 per cent. The marketing of a larger proportion of concentrates having a high iron content was the principal cause of the reduction in the zinc content in sphalerite concentrates recovered from "soft ground." The zinc content of the sphalerite concentrates derived from "sheet-ground" mines, which was 58.6 in the years 1911 and 1912 declined to 58.3 in 1913. The average price received for sphalerite concentrates in 1913 was nearly $10 per ton less than in 1912, but it was slightly higher than the average price for the year 1911.

The zinc carbonate and silicate concentrates sold in 1913 amounted to 21,531 tons, valued at $483,463. This was 641 tons less in quantity and $158,418 less in value than the sales in 1912. The output in 1913 was mainly from southwestern Missouri, the shipments from southeastern Missouri being only 639 tons, valued at $13,491, as compared with 1,051 tons, valued at $21,020, in 1912. The average metal content of the zinc carbonate and silicate concentrates was 38.8 per cent in both 1913 and 1912. The average value per ton in 1913 was $22.45 as compared with $28.95 in 1912.

The combined value of lead and zinc concentrates from southeastern and central Missouri in 1913 (which produced about 84 per cent of the lead) was $9,594,958, or $277,208 less than in 1912. The total value of the southwestern Missouri lead and zinc concentrates was $11,514,400 as compared with $15,064,995 in 1912, a decrease of $3,550,595.

The total quantity of crude ore or "dirt" mined and treated in 1913 amounted to 12,300,100 short tons, a decrease of about 1,085,000 tons, or approximately 8 per cent less than the quantity mined and treated in 1912. As the total amount received for all classes of lead and zinc concentrates sold in 1913 was $21,109,358, the average value per ton of crude ore or "dirt" mined and treated was $1.72, compared with $1.86 in 1912.

The comparatively small quantity of copper ore mined and shipped in 1913 is excluded from these calculations.

In the following tables showing the tenor of crude ore ("dirt") and concentrates from Missouri it has been considered advisable to segregate the ores of different nature. For instance, the disseminated lead ore of southeastern Missouri differs radically from the lead and zinc ores of the so-called "soft-ground" deposits of southwestern Missouri, and these in turn differ from the "sheet ground" deposits of the same region. Each class of ore has its peculiar problems of mining and ore dressing. This fact makes desirable the separate treatment of the statistical data. In general, the tables reflect very closely the conditions of the industry.

Tenor of crude lead and zinc ore and concentrates produced in southwestern Missouri in 1912 and 1913.[a]

	1912	1913
SOFT GROUND.[a]		
Total crude ore.....short tons..	3,856,045	3,745,400
Total concentrates in crude ore.....per cent..	4.21	4.56
Lead.....do....	.34	.44
Zinc.....do....	3.87	4.12
Metal content of crude ore.....do....	2.41	2.58
Lead.....do....	.27	.34
Zinc.....do....	2.14	2.24
Average lead content of galena concentrates.....do....	79.5	78.6
Average lead content of lead carbonate concentrates.....do....	54.8	62.2
Average zinc content of sphalerite concentrates.....do....	58.3	57.5
Average zinc content of silicates and carbonates.....do....	38.8	38.8
Average value per ton:		
Galena concentrates.....	$54.43	$51.51
Lead carbonate concentrates.....	$35.52	$32.66
Sphalerite concentrates.....	$49.99	$39.93
Zinc silicates and carbonates.....	$28.95	$22.45
SHEET GROUND.		
Total crude ore.....short tons..	5,465,100	4,303,900
Total concentrates in crude ore.....per cent..	2.62	2.63
Lead.....do....	.46	.47
Zinc.....do....	2.16	2.16
Metal content of crude ore.....do....	1.62	1.63
Lead.....do....	.36	.37
Zinc.....do....	1.26	1.26
Average lead content of galena concentrates.....do....	79.6	79.0
Average zinc content of sphalerite concentrates.....do....	58.6	58.3
Average value per ton:		
Galena concentrates.....	$55.83	$51.43
Sphalerite concentrates.....	$50.84	$41.69

[a] Including also the small production of lead and zinc ores in central Missouri.

Tenor of crude lead ore and concentrates in southeastern Missouri disseminated lead ore in 1912 and 1913.

	1912	1913
Total crude lead ore.....short tons..	4,064,366	4,250,800
Galena concentrates in crude ore.....per cent..	5.3	5.15
Lead content in crude ore.....do....	3.35	3.45
Average lead content of galena concentrates.....do....	67.1	67.2
Average value per ton of galena concentrates.....	$45.01	$43.63

SOUTHWESTERN MISSOURI.

AREA, ORES, DEPOSITS.

The southwestern Missouri lead and zinc area includes the largest part of the Joplin region, the remaining portion lying in southeastern Kansas and in northeastern Oklahoma. The ore occurs in the Boone limestone and in rocks of Kinderhook age, both belonging to the lower Carboniferous. The ore deposits are found in Jasper, Newton, Lawrence, Greene, and adjoining counties. This area produces about four-fifths of the lead and zinc ore raised in the Joplin region.

The lead ores are galena, with a small quantity of lead carbonate, locally known as "dry bone." The zinc ores are sphalerite, or zinc blende, or "jack," zinc carbonate (smithsonite), and zinc silicate (calamine), both of the latter locally called "silicate." The galena contains but a small fraction of an ounce of silver to the ton of lead concentrates, and although ordinarily it is not desilverized, yet occasionally the refineries find it advantageous to add lead from the

Joplin region to their charges without, however, making any record of the silver content. In this way an unknown but small quantity of silver is recovered from southwestern Missouri lead ore. The zinc ores, sphalerite, smithsonite, and calamine contain notable quantities of cadmium, being fully as rich in this respect as the zinc ores of Silesia, which are the source of the cadmium production of Europe. The discussion of the cadmium content of these ores is taken up more fully in the chapter entitled "Cadmium," in Mineral Resources for 1908.

The ore deposits of the Joplin district vary in character with the depth of mining. The shallower ores beginning at the surface are universally pockety and are found in residual clays or in "runs" in the basal breccias of the region. The breccias and the forms of the "runs" are largely, if not altogether, due to solution of the limestone strata. One form of run, which is fairly numerous, is the "circle" deposit, which, in the popular view, has come to be nearly synonymous with rich deposits. Small veins, vertical sheets, and thin crevice deposits are often met with in prospecting, but unless they develop into stringers leading into paying ore bodies are forgotten in the multitude of rich pockety deposits which the district has yielded. The blanket deposits or "sheet ground" are found in the Grand Falls chert member of the Boone limestone at depths varying from 100 to 275 feet, depending on the topography and the geologic structure. Below this horizon there are, in the rocks of Kinderhook age, deposits of disseminated ore. They have been found in prospect shafts or drill holes near Springfield, Aurora, Granby, Carterville, Joplin, Hornet, and Cave Springs, in Missouri; at Galena, in Kansas; and at Quapaw, in Oklahoma.

ORE PRODUCTION.

Mining and milling practice in the Joplin region is so well known through the numerous articles that have appeared in the mining press of the country that but few words are necessary here. The type of mill erected in the district is carefully chosen to fit the needs of the particular kind of ore body to be exploited and, being based on the evolutionary experience of nearly 40 years, is, in general, wisely selected.

In early days of zinc mining in the district, when only the richest runs and pockets of the "disseminated" deposits could be profitably worked and the life of the individual mine was necessarily short, a very simple type of concentrating plant came into use. It was equipped with a rougher jig and a cleaner jig and had a capacity of 80 to 100 tons of crude ore per 10-hour shift. When a deposit was worked out, the mill could be easily and cheaply moved to another deposit. When the increased price of concentrates made it possible to mine lower-grade ore, and the life of the deposits was thereby lengthened, somewhat larger and more complete milling plants came into vogue. Sand jigs and concentrating tables were added to the equipment, and the capacity was raised to 200 or more tons per shift. Such mills, developed by the necessities of local conditions, came to be characterized throughout the lead and zinc regions of the Central States as the "Joplin type."

A further increase in the price of concentrates and the development of large bodies of low-grade "sheet-ground" deposits, insuring permanence and stability of operation and necessitating every refinement of concentration, have resulted in the modern "sheet-ground mill" with capacity from 350 to 1,000 tons of crude ore per 10-hour shift, driven by steam generated by natural gas, or driven by electricity, with complete equipment of ore-saving devices and with attendant economies of power, operation, and concentration.

For several years many of the concentrating plants used natural gas to produce power but the rapidly declining supply and low pressure in 1912 and 1913 practically eliminated natural gas for fuel. Although coal is probably the cheapest fuel available for small mines having railway switches, there has been a large increase in the number of mining plants operated by means of electric power. Many of the largest and most efficient concentrating plants in the district have changed from steam to electricity, and independent motors are used for hoisting, for the concentrating plant, and for the treatment of slimes. Plants so equipped are enabled to operate economically the mine one 8-hour shift, the mill one or two 10-hour shifts, and the sludge plant continuously. There has been a noticeable increase in the number of slime plants and concentrating tables. This condition applies especially to operations in the "sheet ground" though "soft ground" operators also have concluded that a large saving of concentrates is possible in most cases by the use of more tables to handle the fine ore. Some of the large producing mines like the Priscilla, in the west Joplin camp, the American Davey, at Prosperity, and the Wilson, at Duenweg, have the sludge plants in a separate building and use an independent electric motor. At the Priscilla all the tailings from the rougher, the cleaner, and the sand jigs are flumed to two concrete tanks, one of which is being filled while the other is drawn off. A hydraulic classifier with 8 pockets is used so that each pocket feeds one table. The plant is equipped with 10 tables; the first 8 are fed by the classifier, and the overflow goes to two cones, each of which feeds a slime table. Although this plant has proved to be very efficient and has saved much ore, it is stated that more or less slime gets away in the overflow from the cones. An assay of this slime shows about 7 per cent zinc. More attention undoubtedly will be given to saving the finer particles of blende and galena in both "soft-ground" and "sheet-ground" operations, especially where the "dirt" is chatty and requires fine grinding and where the ore body is known to be large. Once an efficient sludge plant is installed the saving in concentrates materially increases the output at a very small additional cost for power and labor.

ORE SELLING.

As was noted in the introduction to this chapter, the lead and zinc ores of the Central States when marketed locally are sold on a plan which differs somewhat from the methods in vogue in the Western and other States where more complicated ores prevail. The producer is paid by the ton of concentrates, all output being sold in that form. The price is arranged on a sliding scale, the foundation of which is the price paid for ores of a certain standard, namely, the "basis."

In each of the ores a "basis" is arbitrarily taken which represents as nearly as may be the average metallic content of clean concentrate. In sphalerite or zinc-blende concentrate the basis is 60 per cent (theoretical composition, 67 per cent) metallic zinc, by wet assay or analysis; in the oxidized zinc ores, the carbonate and the silicate, the basis is 40 per cent (theoretical, 52 and 54 per cent) metallic zinc; and in galena concentrates the basis is 80 per cent (theoretical, 87 per cent) metallic lead. The buyer will offer so much for 60 per cent zinc ore, which becomes the "base price." If the assay shows the concentrates to vary from the basis, $1 is added to the base price for each per cent of zinc above 60 and $1 subtracted for each per cent less than 60. Deduction is made for moisture, all concentrates being sold on dry, or net, weight. Penalties are exacted for the presence of undesirable elements, as iron, bitumen, barite, fluorspar, etc. One dollar is deducted for each per cent of iron above 1 per cent.

Very little ore in the Joplin region is at present heavily penalized for iron. The concentrates from the Miami district derived from the upper run of ore were high in iron content, but for the last two years the quality of blende concentrates from Miami compares favorably with that of most of the other camps. Some of the ores from the Thoms station district have had a greater iron content than other districts in Missouri. Bitumen has not been troublesome except in the early years of mining at Miami, though it has been noted in a small quantity of concentrates from a mine near Alba. The small penalty incurred in selling Joplin blende concentrates is shown from the composite assays of sphalerite furnished by W. George Waring, of Webb City, and W. W. Petraeus, of Joplin.

Fluorspar occurs in the zinc concentrates of western Kentucky and southern Illinois, but neither fluorite nor barite are found in quantity in the ores of the Central States except in some mines in central Missouri and in a single mine in the Joplin district. The practice of buying zinc blende concentrates on an assay basis became general in 1899, though it began in a small way a few years earlier. Formerly the ore was bought on "flat bid"—that is to say, the buyer made a visual inspection and mental estimate of the metallic contents and then offered so much per ton for the particular concentrates in question. An expert buyer can estimate the metallic contents very closely. Galena concentrates are generally bought on flat bid, though buying on assay is increasing. Ore which is sold in lump, such as hand-picked galena, lead carbonate, and carbonate and silicate of zinc, is very generally sold on flat bid.

ASSAYS.

Several of the assayers in the Joplin district make a practice of saving the remnants of blende samples analyzed during the year. At the close of the year the lot is thoroughly mixed and carefully sampled, from which sample an average or composite assay for the year is made. Each assay thus represents several thousand lots. Two representative series of such composite assays are given below. In most cases each sample included in the composite assay represents a carload lot of concentrates.

The first series, by W. W. Petraeus, of Joplin, gives the result of analyses of composite samples from the general district for the last

14 years. The analyses for 1897–1905, inclusive, were published in the Lead and Zinc News, volume 9, January 15, 1906, page 8. The analyses for 1906–1913 were kindly communicated by Mr. Petraeus. Iron was not taken into account until 1900. Some 400 scattering assays, made in 1895–96, are excluded from the table.

Composite assays of zinc blende from the Joplin region, 1897–1913.

[W. W. Petraeus, analyst.]

Year.	Number of lots in the composite.	Percentage of zinc.	Percentage of iron.	Percentage of lead.	Percentage of copper.	Percentage of cadmium.
1897	600	56.64				
1898	1,299	56.99				
1899	3,715	56.67				
1900	3,500	57.36	0.22			
1901	3,683	57.53	2.02			
1902	5,776	57.08	2.24			
1903	6,014	57.30	2.00			
1904	6,220	57.24	2.10			
1905	4,628	57.97	1.84	1.00	0.001	0.198
1906	5,644	57.2	2.00			
1907	6,813	56.8	1.93			
1908	7,837	56.4	1.76			
1909	9,002	56.3	2.00			
1910	8,892	56.6	2.10	1.02	.06	.399
1911	8,920	57.1	2.40			
1912	9,474	57.7	2.40			
1913	7,010	57.1	2.40			

The next series of composite assays was communicated by Prof. W. George Waring, of Webb City. The original samples were of ores from the different camps of the district except where otherwise indicated. The methods used in making these assays have been published.[1]

Composite assays of zinc blende from the Joplin region, 1900–1913.

[W. George Waring, analyst.]

Year.	Number of lots in the composite.	Zinc.	Iron.	Lead.	Cadmium.	Copper.
	Lots.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1900	3,894	57.30	3.03			
1901	5,172	56.00	3.30			
1901	2,757	55.30	3.86			
1901	[a] ±2,000	55.90	3.47			
1902	2,270	57.08	2.65	0.904	0.337	0.050
1903	2,145	57.75	2.32	1.072	.388	.049
1904	[a] 3,800	58.26	2.23	.701	.304	.049
1904	[b] 2,691	58.46	1.97	.720	.430	.050
1904	1,984	58.95	2.10			
1905	4,520	58.95	2.00			
1906	4,638	58.40	2.20			
1906	3,968	58.20	2.29			
1907–8	±4,000	58.70	2.00			
1909		[c] 57.40	2.60			
1910	6,377	[c] 57.90	2.60			
1911	5,653	58.20	2.35	.856	.450	.034
1912	6,709	56.72	2.50	1.070	.256	.022
1913	7,364	56.82	2.81	1.112	.209	.036

[a] Joplin. [b] Webb City. [c] The composite sample included some lots of silicate ores.

[1] Waring, W. G., The Volumetric determination of zinc: Jour. Am. Chem. Soc., vol. 26, No. 1, January, 1904. In addition to the composite assays for 1902 and 1903, shown in the table, the article gives the lead, copper, and cadmium content of a number of ores from individual mines in Missouri, Kentucky, and Illinois.

The complete analysis of the composite sample of the 3,800 lots of concentrate from the Joplin district in 1904, sampled by C. V. Millar and analyzed by Waring, is as follows:

Analysis of composite sample of zinc blende from the Joplin region.

Zinc	58.26	Calcium carbonate	1.88
Cadmium	.304	Magnesium carbonate	.85
Lead	.70	Barium sulphate	.82
Iron	2.23	Silica	3.95
Manganese	.01		
Copper	.049		99.773
Sulphur	30.72		

PRICES AND PRODUCTION.

Although the prices paid for all classes of lead and zinc concentrates in 1913 were very much lower than in 1912, the production held up remarkably well. The decline in prices paid for zinc concentrates was very much greater than in the selling price of lead concentrates. The reported sales of galena and lead carbonate and zinc silicate and carbonate concentrates from southwestern Missouri were only slightly less than in 1912, but the shipments of sphalerite declined approximately 19,000 tons. It is customary to sell the galena concentrates and the zinc silicate and carbonate as soon as possible and there is seldom any accumulation of these classes of ore regardless of the prices prevailing. Thus the sales of these classes of ore may be regarded as the approximate production for the year. When prices offered are considered low, some sphalerite (though it seldom is more than one or two weeks' normal output) is held for higher prices, so that the production of sphalerite in southwestern Missouri was probably 7,000 or 8,000 tons in excess of the reported sales of 225,817 tons. Prices for zinc concentrates showed a steady decline throughout the year with the exception of the month of August, when prices rallied for about three weeks. The average quoted base price for 60 per cent blende concentrates was highest during the first three weeks in January, when the base price quoted was from $52 to $54 a ton. In the last week in January the price declined to $51, and in February the base price rapidly declined to $44. The market stiffened slightly during the first three weeks in March; then the price dropped to about $40. During April, May, June, and July the weekly base priced remained about $40 to $42. Prices advanced gradually in August as high as $48, then steadily declined during September and October, until $39 was the average price. The prices advanced slightly the first part of November, only to slump badly at the end of the month. The average price was lower during December than for any month of the year, varying from $40 to as low as $35.

Base prices for calamine or zinc carbonate and silicate concentrates followed generally the variations in sphalerite quotations and were highest, at $34, in January and lowest, at $20, in December.

The quoted prices for galena concentrates were not subject to such a wide fluctuation as those of zinc. The market opened in January at $52 to $54 a ton and held quotation steadily until the middle of August, when prices reached $53 and $54. The quoted prices advanced to $57 and $58 at the end of September, then steadily declined until $46.50, the low point of the year, was reached in December.

The average price paid for sphalerite or blende in 1913 was $40.70, as compared with $50.44 in 1912, and with $39.86 in 1911, and for zinc silicate or carbonate (calamine) concentrates it was $22.45 in 1913, $28.95 in 1912, $23.76 in 1911, and $23.58 in 1910. The average price paid for galena concentrates was $51.50 in 1913, as compared with $55.36 in 1912 and $55.75 in 1911. These prices are not average base price quotations, but are the actual average prices calculated from the tonnage sold and the values reported to the United States Geological Survey by the sellers.

The prices received by the producers show that the average actual selling price of sphalerite in 1913 was $9.74 a ton less than in 1912 and that the corresponding decrease in prices for zinc carbonate and silicate was $6.50 per ton.

The average metal content of sphalerite concentrates derived from "soft ground" declined from 58.3 per cent in 1912 to 57.5 per cent in 1913, and those derived from "sheet ground" from 58.6 per cent in 1912 to 58.3 per cent in 1913. The average metal content of the galena concentrates derived from both "sheet" and "soft" ground was also less in 1913 than in 1912.

The recovery of sphalerite and galena concentrates from "sheet ground" was approximately the same for the years 1910, 1911, 1912, and 1913, indicating clearly that about 2.6 per cent of concentrates is what may be expected as the approximate recovery for a term of years from this class of mining. The average recovery of concentrates from "soft ground" increased from 3.87 per cent in 1912 to 4.12 per cent in 1913, showing that the tendency was to mine "dirt" carrying a larger quantity of lead and zinc, which was a natural result of the lower prices paid for concentrates during most of the year.

The total tonnage of ore or "dirt" treated decreased from 9,321,145 tons in 1912 to 8,049,300 tons in 1913. The ore treated from "sheet ground" was 4,303,900 tons, a decrease of over 1,160,000 tons, and that from "soft ground" mines was 3,745,400 tons, a decrease of only about 110,000 tons.

In 1913 the sphalerite concentrates derived from the "sheet-ground" mines amounted to 92,912 tons and the galena concentrates to 20,389 tons. In 1913 the "soft-ground" mines yielded 132,938 tons of sphalerite, 16,152 tons of galena, and all of the lead carbonate, zinc silicate, and zinc carbonate concentrates. The total value of all concentrates derived from "sheet-ground" mines was $4,920,898, and from "soft-ground" mines $6,634,831. This shows that the value of the production of concentrates from "soft-ground" mining amounted to about $1,713,933 more than the production from "sheet-ground" mining, although the ore or "dirt" milled or otherwise treated was 558,500 tons less.

The value of the production from "sheet-ground" mines in 1913 was about $2,475,000 less and that from "soft-ground" mines about $1,034,000 less than in 1912.

The radical change from very high prices paid for concentrates in 1912 to low prices during most of 1913 was naturally reflected in the decreased output of about 24,000 tons of sphalerite and 4,000 tons of galena derived from "sheet-ground" mining. The low prices operated in two ways to affect a decreased output from "sheet ground." First by closing down mines when the cost of production was in excess of $40 to $45 per ton of sphalerite. Second, by the exhaustion of the

ore bodies in a number of "sheet-ground" mines, which was not compensated for by the opening of new mines of a similar character. Partly balancing the decreased output from "sheet-ground" mines, was an increase of about 3,500 tons of galena concentrates and 6,000 tons of sphalerite concentrates from "soft-ground" mines. This increase was due to the continued operation of some rich mines developed in 1912, and to the increased number of small mines worked by persons thrown out of employment by the closing of properties which were unprofitable with ore at prevailing prices. Low-priced ore in the Joplin district has always resulted in increased prospecting in "soft-ground" camps. Miners thrown out of employment who are unwilling to accept the wages automatically reduced by lower ore prices obtain leases and prospect for ore bodies suitable to work by means of hand jigs or to develop sufficiently to sell to large operators. The cut in wages was made reluctantly by operators and accepted generally by the miners as inevitable, so that no labor troubles occurred. The producers also realized that the smelters offered fair prices for concentrates when the low prices of spelter and lead were considered.

The Webb City-Carterville-Prosperity district, which includes most of the "sheet-ground" mines, was again, notwithstanding conditions, the largest producer of both blende and galena concentrates. It produced 60 per cent of the galena concentrates and over 34.3 per cent of the sphalerite sold in 1913. In 1912 it produced 64 per cent of the lead and 41 per cent of the sphalerite.

The quantity of crude ore or "dirt" raised is a better indication of the extent of mining activity than the production of concentrates, for the "sheet-ground" ore is of lower average tenor than the "soft-ground" ore. The leading position of the district is more adequately shown by the fact that the estimated tonnage of ore mined in the Webb City-Prosperity district in 1913 was about 3,651,500 tons, or nearly 45 per cent of the total tonnage of crude ore raised in southwest Missouri. Joplin, the second most productive district in 1913, showed a decrease in galena concentrates of about 700 tons, in zinc blende of about 1,000 tons, and in zinc carbonate and silicate of 1,000 tons.

The production of all classes of concentrates at Duenweg enabled that district to retain third place by a considerable margin, though the output of sphalerite was less in quantity (but not in value) than that of the Thoms Station district. Although the Alba-Neck City 1913 production compared favorably with that of 1912, the gain made by the Thoms Station-Sherwood district in both lead and zinc concentrates advanced it to fourth place and put the Alba-Neck City district in fifth place. The districts showing a notable increase of production in 1913 were Zincite-Klondike-Belleville camp, Carl Junction, Duenweg, and Reeds-Sarcoxie. Development work which makes possible larger outputs in 1914, was especially noteworthy in the Spring City and Alba-Neck City districts. The most important developments during 1913 are described under the various district reviews.

REVIEW BY DISTRICTS.

Alba-Neck City district.—The shipments of sphalerite from this district in 1913 decreased about 1,000 tons and those of lead about 500 tons. This was due entirely to a decreased output from the small

group of mines northwest of Neck City which have been and still are large producers. The Cliffwood, Quick Seven, and Little Mary mines in 1912 produced about two-thirds of the total sphalerite output of the district, taking advantage of high prices to crowd their yield of concentrates. In 1913 the yield of this group of mines was only about 50 per cent of the district production. The output of the mining lands in the immediate vicinity of the towns of Alba and Neck City increased. Rich ore bodies were developed; several new mills were erected; and old mines were worked again. The production actually increased during that part of 1913 when ore prices were lowest and the district was one of the most active in the Joplin region. Even with low prices, the dirt was sufficiently rich to pay well. Moreover, the sphalerite from most of the mines averaged 60 per cent or more in zinc content and some averaged 61.5 per cent. The concentrates produced from tailings and sludge being deducted the sphalerite shipped ran 60 per cent zinc content and brought a better average price per ton than that obtained for sphalerite shipped from any other district. Most of the mines reported no output of galena and the closing of the Virginia mine was the cause of the decrease in lead production. The zinc blende production of the Quick Seven Mining Co. was again the largest in the district. Two shafts, 140 and 164 feet in depth, were in operation, and ore was also taken from an open cut caused by caving ground. The ore body comes within 15 or 20 feet of the surface and the ground is very soft, so that the cost of breaking and hoisting the "dirt" is less than in most mines in southwest Missouri. There are on this land four concentrating plants having an aggregate milling capacity of 700 tons, but the output in 1913 came from the 200-ton mill of the first lease owners.

The Little Mary Mining Co. was the next largest producer of sphalerite in the district in 1913. The concentrates sold averaged 61 per cent zinc and contained little or no lead. The concentrating plant has a capacity of 250 tons, and the ore was hoisted from the 145-foot level by means of one shaft.

The Cliffwood Mining Co., on the Durston Mining Co.'s land, produced a large quantity of high-grade concentrates, but sold no galena. Three shafts were utilized to hoist ore from the 140 and 185 foot levels. The 2 concentrating plants, with capacities of 125 tons and 250 tons, are operated by electric power. The property was subleased to Gould & Co. during the last half of the year.

A large portion of the galena concentrates produced in the district, as well as a good production of the blende concentrates, came from the Reliance Mining Co.'s land. Among the lessees working were Spawr & Co. (Annalinda), Greene & Co., Jessie Milling Co., M. & W. Mining Co., and the Longacre-Chapman Mining Co. The last named was the largest producer, and the Jessie Milling Co., which has a 175-ton mill, made the next largest output.

The Longacre-Chapman Mining Co. commenced operation in the middle of the year purchasing several leases on the Reliance and adjoining lands. The development by means of drilling, shaft sinking, and drifting showed extensive deposits of high-grade "dirt." The Federated mill of 200 tons capacity was purchased, and after reconstruction turned out some of the highest-grade sphalerite ever recovered in the district. During the latter part of the year the output from the Longacre-Chapman land and leases was the largest in the

district. The Century Zinc Co. leased part of the Longacre-Chapman land and moved the old Independence 150-ton plant from Gordon Hollow. The mill was not in operation until late in September, but the dirt milled was so rich that the shipments were large during the last three months of 1913.

S. L. Bradley has also opened up a good mine on Reliance ground, sunk a shaft, and drifted into the ore body. A concentrating plant was purchased but was not built in 1913. Another newly developed mine situated near the Longacre-Chapman property was that of the Red Brush Mining Co. on the Stewart & Gill land. The shaft at this mine was sunk to the 189-foot level, and a 150-ton concentrating plant was erected, which was in operation late in the year.

The Penn Zinc Co. land at Neck City was operated in 1913 by the Bull Dog Mining Co. and Smith & Co. There are two shafts 160 feet deep on the land and a 100-ton mill. Longacre & Chapman have secured a lease on part of this land near their own property and have done some prospecting.

The Davidson-Joplin Mines Co. leased the Fox, J. M. Wheeler, Lanyon, and part of the Aylor land and expended a large amount of money in pumping and mill repairs to the 250-ton mill at the Water Oak mine. About 10 shafts were in operation in 1913, and the water level was lowered to 200 feet. There are two other mills, the Sunflower of 100 tons and the Battle Axe of 150 tons, on the leasehold. A good output of sphalerite was made, and the largest part of the galena and zinc silicate credited to the district was taken from shafts about 75 feet deep. The productive subleases were the Battle Axe and the Little Red on the Wheeler land, the Cathers and the Case on the Fox land, and the Sunflower, Davis, Broken Four, and Ralston on the Aylor land. The Battle Axe tailings on the Wheeler land were worked by H. H. Veach.

Part of the Aylor land was under lease to the East Side Mining Co., which was one of the largest shippers of sphalerite in the district. The mine is opened by means of a 145-foot shaft and equipped with a 200-ton concentrating plant. A shaft was sunk on the Holton land at Alba by the Saturday Mining Co., and some production of sphalerite and galena was made. Other producers of concentrates from ore or tailings were the Jumbo Mining Co. on the Sponable land, Shamrock Mining Co. on the Bowen land, Horseshoe Mining Co. on the Haworth land, Bartholow Sludge Co. and Busy Bee Mining Co. on Penn Zinc Co.'s land, and the Lorraine Mining Co. on the Robinson & Baker land.

Ash Grove-Everton district.—The mining in this vicinity is all shallow, none of the workings exceeding 50 feet in depth. The ore is raised by means of horse whims and cleaned on hand jigs. Most of the lead was mined on the Duncan land in Boone Township by Haydon & Co., Neidinger & Co., and Elts & Brown, and shipped by E. A. Hurt. The zinc carbonate and silicate produced was mainly the output of the lessees on the John A. Hall land near Corry. The production of both galena and zinc silicate was considerably less in 1913 than in 1912.

Aurora district.—The production of lead concentrates of this district in 1913 was about the same as in 1912. The output of zinc silicate and carbonate increased 174 tons, but the production of sphalerite declined nearly 600 tons. A large proportion of the output

was made by lessees working shallow ground, the crude ore or "dirt" being treated at custom mills or sold in the rough. Most of the mining was on a small scale, and little new work was undertaken other than that by the Chat River Mining Co. This company in 1912 installed pumps on the United Zinc Co.'s land to lower the water level and thus enabled the sublessees to mine ore which had been inaccessible, as many pumping plants at mines working at lower levels have been idle. The sublessees of Stratton Bros. and of the Chat River Mining Co. produced a large part of all the zinc silicate dirt mined in the district. This dirt which is hoisted from above the 40-foot level was sold in the rough to chatting plants, as there was no concentrating plant on the United Zinc Co.'s land.

The Early Dawn Mining Co.'s operations were confined to the Sedalia land, and a large production of zinc silicate was made until October, 1913, when the lease was taken over by E. J. Sanders. The ore was mined from the 100-foot to the 110-foot level and was treated at an 80-ton concentrating plant. The Daisy Bell Mining Co., Blue Jay Mining Co., and the Chat River Mining Co., had leases on the Decatur land. Three shafts 130, 90, and 40 feet deep were used in 1913. The Daisy Bell mill, which has a capacity of 100 tons, was run partly on custom ore. There were seven leases on the Sphalerite Mining Co.'s land that produced lead or zinc concentrates in 1913. The property is equipped with a 100-ton mill.

There was no mining on the land of the Milton Mining Co., but the Buckeye mill operated by C. C. Plank purchased dirt and sold about one-fourth of all the zinc silicate shipped from Aurora. Other producers of crude ore or concentrates were the lessees of the Black Land & Mining Co., Cleveland Aurora Mineral Land Co., Chicago Aurora Lead & Zinc Co., Geo. R. Tooker, and the Midland Mining Co. The Aurora Sludge Mill Co. also made some recoveries of sphalerite and zinc silicates from sand.

Several tracts of idle mining land formerly held by outside interests were sold to local investors, and money has been collected to commence drilling operations with a view to locating ore bodies below the shallow levels now worked.

Carl Junction district.—The production of lead concentrates in the district increased 53 tons and that of sphalerite concentrates 3,150 tons. This large increase was caused mainly by the steady operation of the Chicago Lehigh Mining Co. on the United Zinc Co.'s lease of the Avondale and Knight lands and the United Lehigh lease of the Ishpeming land. The Chicago Lehigh Mining Co. made a large output of sphalerite concentrates from ore mined at the 140-foot level by means of two shafts (the Ishpeming ground being worked through the Knight shaft), and development showed an extension of the ore bodies to the east. The concentrating plant driven by electric power has a capacity of 250 tons per 10-hour shift and was equipped in 1913 with 4 Wilfley No. 3 concentrating tables and 2 Ford No. 5 slime tables. Other producing leases on Avondale ground were the United Lehigh, Webb City Lehigh, Teddy Bear, and Fare & Co. The ore mined at these leases was extracted from the 105-foot and the 125-foot levels by means of 4 shafts and was treated at a 100-ton plant. On the C. F. Dynes lease of Avondale land some production was made by the Gager Mining & Milling Co., Richards & Co., and the Pearl Lehigh Mining Co. Five shafts were in operation, and the

average depth of the mining was 90 feet. The 100-ton mill was operated intermittently. That part of the Knight land not leased to the United Zinc Co. produced nearly all the galena shipped from Carl Junction in 1913 and also a fair output of sphalerite. Most of the production was made by the Federated Mining & Milling Co. from ore mined at the 150-foot level and milled at a 250-ton concentrating plant. The Moler-Smith Lead & Zinc Co.'s production in 1913 compared favorably with that of 1912. Most of the ore was extracted from an open cut 90 feet deep and trammed to the 200-ton mill. A part of the production came from the leases of Morbaugh Bros., Cherry Tree Mining Co., Benscotter & Co., and the Last Chance Mining Co.

The production of the Interstate Trust Co.'s mine was small and the property was idle most of the year.

On the Isherwood land north of Carl Junction, Gaines & McCarren drilled several holes, obtaining rich cuttings. A 150-foot shaft was sunk, through which dirt running 10 per cent in zinc concentrates, having a zinc content of 62 per cent, was recovered by means of hand jigs. About one-fifth of the sphalerite credited to the district was recovered by the Rockford Mining Co. and Weeks & Briggle operating on the Anderson land, 4 miles north of Carl Junction. The ore is mined in soft ground at a depth of about 110 feet. The sphalerite is high grade, and the ground contains galena in small quantities only. Caving ground at the Rockford damaged the mill and reduced the output.

The ore deposits mined on the Anderson land are several miles from other producing mines, and considerable drilling was done in the endeavor to locate other deposits. About 2,000 feet of drilling was done on the Rice land by F. M. Braun, but although the clippings showed zinc shines, no shaft was sunk.

Carthage district.—Reports from this district showed that the production of lead concentrates declined 36 tons, and the sphalerite, 848 tons, in 1913, when compared with 1912. About one-third of the sphalerite was derived from the milling of old tailings, and the Wise Guy Milling Co. was the largest producer in the district. No ore was mined on the Vesuvius land, and the 100-ton concentrating plant ran entirely on tailings. The exhaustion of the tailings after a long and successful reworking compelled the removal of the plant. The Wakefield & Hodson land was mined for a short period by the Vesuvius Mining Co., but the output was small. The largest production of zinc concentrates from ore was that of the Linzie Hill Mining Co. from the Little Persimmon mine on the Buehler land. The ore was taken from the 200-foot level and was concentrated at a 150-ton plant.

The Hermosa Mining Co. leased the Amsden land 2½ miles northwest of Carthage in the spring of 1913, put down several drill holes, and sunk a second shaft to the 170-foot level. The opening of good ore bodies and the improvements at the mine and in the mill resulted in making the property the most productive in the district during the latter part of 1913.

The only production from the Mignonette land was that of the J. L. Edwards sludge plant. The Sampson (Cornell) mine was operated for a short period in 1913, first, by the Live Wire Zinc Land

Co. and afterward by the C. C. Playter Mining Co. The output was comparatively small and the mine was closed down most of the year.

Nearly all of the zinc silicate ore was shipped from the Cobaugh sublease of the Lone Star Mining Co. on the Bergner land. The ore was all obtained by means of shafts 10 to 30 feet in depth. That part of the G. M. Mining Co. leased to S. Y. Ramage produced some sphalerite and zinc silicate and the only galena shipped from Carthage in 1913. Three shafts ranging from 65 to 140 feet were sunk and the dirt was concentrated by means of hand jigs. The Ramage lease was forfeited in September, and the landowner continued drilling the property. It was reported that good ore bodies had been located below 130 and 165 feet on the western portion of the tract.

Cave Springs district.—The production of galena concentrates decreased from 384 tons in 1912 to 181 tons in 1913, and the production of blende concentrates decreased from 5,979 tons in 1912 to 3,331 tons in 1913. The largest operator in the district, H. L. Kramer, on the Miami Realty & Mining Co.'s land, ceased mining in June, so that the output of the Kramer mine was only about half of what it was in 1912. After the property remained idle some months, it was leased to the Cave Springs Lead & Zinc Co. and it will be worked in the upper level at 130 feet. The other large producers at Cave Springs were the Big Brownie and Cave Springs leases on the Schmidt Bros. & Schemmerhorn land, both of which leases are equipped with concentrating plants of 100 tons capacity. The Big Brownie was closed down the last part of 1913, but preparations have been made to resume mining in the big open cut. A rich deposit of shallow ore was developed on the Schmidt Bros. & Schemmerhorn land by the Grass Roots Mining Co., and a good yield of concentrates was derived from ore treated at a custom mill.

The production by sublessees of McCullough & Murdock on the Hartley land was less than in 1912. Several new lessees, however, developed shallow ore, and prospects are favorable for a large increase of both lead and zinc in 1914.

Duenweg-Porto Rico district.—Though this district is one which contains a number of "sheet ground" mines, several of which were idle most of 1913, the total production of lead and zinc concentrates showed an increase when compared with 1912. The production of sphalerite declined from 21,728 tons in 1912 to 20,075 tons in 1913, but the quantity of galena concentrates increased from 2,747 tons in 1912 to 4,051 tons in 1913, and the quantity of zinc silicate from 1,325 tons in 1912 to 1,991 tons in 1913. The "sheet ground" mines produced about 40 per cent of the lead and 60 per cent of the sphalerite. About half of the galena concentrates recovered from "soft ground" came from mines developed on the Walker land. The largest producers of sphalerite concentrates in 1913 were the Coahuila, Gopher (Lincoln), and Wilson mines, in the order named. Most of the zinc silicate was produced by lessees of the Hall and the Royalty Land & Mining Co. lands.

The Coahuila Mining Co. on the Horton land worked a 30-foot face of ore in "sheet ground" at 230 feet. The concentrating plant has a capacity of 300 tons and is fully equipped with tables to save the fine ore. The production of the Gopher Mining Co. from the old Lincoln mine on the Jasper Royalty Co.'s land was much larger

than it was in 1912. "Sheet ground" was mined by means of two shafts, 252 feet deep, one of which was in operation for four months only. The electrically driven concentrating plant has a capacity of 350 tons per shift of 10 hours.

The production of concentrates from the land of the Boston-Duenweg Mining Co. was larger in 1913 than in 1912. Most of the output was due to operations by the Wilson Mines Co., which hoisted ore from a depth of 172 feet by means of two shafts. The capacity of the concentrating plant was increased from 250 to 400 tons. The Oakland Mining Co. moved the old O. F. L. 200-ton mill to the Boston-Duenweg land and made considerable output from "soft ground" through a 142-foot shaft. Several other lessees worked shallow ground or tailings.

The Vogey mine and large mill of the American Lead, Zinc & Smelting Co. was operated for a part of the year, and the shipments of sphalerite were much smaller than in 1912. The pulling of the pumps at the Vogey mine which drained a large part of the "sheet ground" area, necessitated the installation of heavier pumping equipment at the other mines working in "sheet ground."

The Carmean & Squires Zinc Mining Co. operated on the Trinity land. One shaft was used to hoist ore from the "sheet ground" at about the 200-foot level, and the ore was milled at the Whitsett mill until the mill was destroyed by fire in April.

The Grand Haven Mining Co., on the Ping land, ran a 150-ton mill until April on ore from "soft ground." Two concentrating plants, one of 100 tons and one of 150 tons, were in operation by lessees on the Knol land. Ore from "soft ground" between 100 and 150 feet was hoisted through 4 shafts.

Operators of the Melrose and Nowata mines on the Baker land used a surface tramway, with locomotive and cars, to convey the ore from a distant shaft to a 200-ton concentrating plant. The output of galena and sphalerite from ore in "sheet ground" formation was quite large. A fair output of galena, zinc silicate, and sphalerite was obtained from the Royalty Land & Mining Co.'s property by various lessees.

Much of the new development in the district was on the J. J. Walker land and the mines opened added considerably to the output of concentrates. On the Wallower lease the Hatcher Mining Co. produced galena and zinc silicate from the 100-foot to the 110-foot levels. On the R. L. McGee lease one of the most productive "soft ground" mines in the district was developed. The ground was opened by means of a 140-foot shaft, and the concentrates were recovered on a small mill cheaply constructed. The upper level, at 140 feet, of the Duenweg Lead & Zinc Co.'s lease on Walker land was exhausted, but a lower run of ore at 160 feet was then worked. The dirt is milled at an electrically-operated concentrating plant of 250 tons capacity. The Little Bob Mining Co., also on the Walker land, exhausted the deposit of zinc ore mined at 140 feet early in 1913, but drill prospecting showed an extensive body of galena on the north side of the lease. Shafts were sunk and the dirt trammed to the 150-ton mill located on the old shaft. This new mine shipped more galena than any other mine in the district.

The old Central States mine on the Home Talent Mining Co.'s lease of the Hall land was operated by the Buckeye Hoosier Mining

Co. and produced a larger part of the zinc silicate ore in this district, although only worked for a part of the year.

The L. K. Smith land held under lease by Douglas & Anderson, was worked by sublessees and made a good production of both lead and zinc from ore mined at levels varying from 60 to 100 feet and from old tailings remilled.

The Thanksgiving Mining Co., mining in "sheet ground" at 190 feet, opened the ore body by means of 3 shafts. The mill of 300 tons capacity was operated during part of the year until the low prices paid for ore and the heavy cost of pumping after the closing down of the Vogey mine made operations unprofitable.

The What Cheer Mining Co., which sunk a 220-foot shaft and built a 200-ton concentrating plant on the Clara Baker land in December, 1912, made a considerable output of both galena and sphalerite in 1913.

Other producers of the district in 1913 were lessees of the Cunningham-Kane land, Burch land, Chase land, Crown Crest Land & Zinc Co., Saddtler Lead & Zinc Co., and the Log Cabin Mining Co.

The only output from the Diamond or Scotland camps was galena and zinc silicate produced by J. L. Miller on the Weymann land and by Geo. James on the Gregg land.

Granby district.—The output of sphalerite concentrates in this district in 1913 was more by 125 tons and that of lead concentrates by 184 tons than in 1912. The production of zinc carbonate and silicate concentrates increased 795 tons. Over one-half of the output of zinc carbonate and silicate concentrates from the Joplin region came from the Granby district. Some ore was derived from the J. B. Davis and St. Paul Mining Co. lands, but most of the producing territory belongs to the Granby Mining & Smelting Co. The total production was large, the relative quantities of zinc silicate, zinc blende, galena, and lead carbonate being in the order named. Much of the mining by small companies and by individuals is in shallow workings that yield galena and zinc silicate ore. The larger producing lessees on the Granby lands were the Broken Hill Co., Golden Rule Mining Co., Jack Snipe Mining Co., Little Boss Mining Co., Mascot Mining Co., Katy Mining & Milling Co., J. R. Underwood Mining Co., Billiken Mining Co., Granby Sludge Co., Automobile Mining Co., Brotherhood Mining Co., Hash Richardson Co., Painter Dahnke & Co., Fortune Teller Mining Co., Tammany Mining Co., Local Mining Co., Pierson-Cook Mining Co., Trilby Mining Co., W. W. Smith Mining Co., Swindell Mining Co., Merry Pepper Mining Co., and Howerton & Son. The depth of mining varied from very shallow openings to 215 feet, and 10 concentrating plants were operated.

The 200-ton concentrating plant of the Granby Mining & Smelting Co., the largest in the district, is so equipped that it can be used to concentrate either blende or calamine ore. Many of the lessees on this land have no concentrating equipment and a large tonnage of ore is treated at custom mills or sold in the rough.

Several churn drills were in operation on the Granby land, and considerable bodies of ore were definitely located.

The Mascot and Homestake mines were reopened by the Underwood Mining Co., and the mills on both leases were put in repair. The only production from the St. Paul Mining Co.'s land was zinc

silicate recovered by means of hand jigs. A small quantity of sphalerite and zinc silicate concentrates was recovered from ore and old tailings on the Davis land.

Joplin district.—The Joplin district, as usual, made the second largest production in southwest Missouri. The sales of concentrates in 1913 were as follows: Galena, 3,963 tons; lead carbonate, 106 tons; zinc blende, 42,061 tons; zinc carbonate and silicate, 1,457 tons. The total value of all concentrates sold was $2,017,372. As compared with 1912 the sales in 1913 of galena and lead carbonate decreased 639 tons, zinc blende decreased 971 tons, zinc carbonate and silicate decreased 1,063 tons, and the total value decreased $458,156.

The number of producers reporting was larger than in any other district, and the area included in the camp is more extensive. About 66 per cent of the zinc blende and 64.6 per cent of the galena concentrates were recovered from ore mined in "soft" ground.

The per cent of recovery of concentrates from "sheet ground" was greater in 1913 than in 1912. This was due to the largely increased output of the Priscilla, Geronimo, Falls City, and Cragg mines. Several former producers in the west Joplin "sheet ground" were closed down and the plants dismantled, but as none of these were large producers in 1912 their idleness had little effect on the decrease in production.

Although the production of the Joplin district showed a small decrease in output of lead and zinc concentrates, new mining developments and increased output of the outlying camps at Thoms Station, Klondike, Carl Junction, and Spring City, showed that the "soft ground" mines were being more actively worked as "sheet ground" mining declined. Many of the mines in these places are locally classed as belonging to the Joplin district and their output included with that of Joplin, and in considering the relative output of Joplin camp compared with that of the eastern and the extreme western districts of the Joplin region, the output of these camps must be taken into consideration.

In general the mines in the vicinity of Joplin, and especially those near Chitwood, had a smaller production in 1913 than in 1912, but there was a large increase from the western part of the district locally known as Central City. There was considerable prospecting, and many small mines were opened; but it seemed difficult to induce investors to purchase and equip mining properties in face of discouraging prices for ore.

Lands owned by the Connor Realty Co., north and west of Joplin, produced about 22 per cent of the sphalerite in 1913. The value of the lead and zinc concentrates was greater than that mined from the property of any other landowner in the district, though the mines on Granby land and Continental land produced more galena. The Connor land near Chitwood yielded a good output of concentrates, but the larger portion of the shipments were made by mines operating on the Central City tract. The Long mine (formerly Lola), was steadily operated by D. King and made a good output. Concentrating plants were erected by the Arco Mining Co. and the Du .das Mining Co. in 1913, but the new plants made only short runs about the end of the year. Other moderate productions were made by the Frisco Sludge Co. and Red Wing Mining Co., also by the Short Creek Mining Co., which not only operated a mine at

Central City but also milled custom ores. The larger portion of the output of sphalerite from Connor lands was that made at the Geronimo and Priscilla mines. The Geronimo has a 140-foot shaft and an electrically operated mill of 300 tons capacity. The leasehold and the surface equipment was purchased late in the year by the Underwriters Land Co., which owns the adjoining mine, the Priscilla. The Underwriters Land Co. was the largest shipper of sphalerite in the Joplin district in 1913, the production being derived from the Priscilla and Geronimo mines on the Connor land and from the Falls City mine on the Liberty land. At the Priscilla mine ore was hoisted from "sheet ground" at the 110 to 120-foot levels. The mill, which is operated by electric power, has a capacity of 400 tons, and the sludge plant is equipped with 10 tables. The plant is a very efficient one, the product of the jigs running 62 per cent in zinc content and that of the tables as high as 58 and 57 per cent. The waste sand, being free from slime and dirt, is a very desirable concrete material and is sold for that purpose. The Falls City mine was taken over by the Underwriters Land Co. and operated by it the last 9 weeks of the year. The mill at the Falls City mine has a capacity of 300 tons and the Martha Ball mine, on the same land, which was in operation part of 1913, is equipped with a 250-ton plant.

The production of lead concentrates by lessees on the Joplin tracts of the Granby Mining & Smelting Co. was only exceeded by that from Continental land and that of zinc concentrates was only exceeded by the output from Connor land. The land owners did considerable prospecting and operated the B. & H. mine. The average depth of mining by Granby lessees was 150 feet, and 10 concentrating plants, with an average capacity of 100 tons each, were operated. The producing mines on the Granby lands were the Amalgamated (250-ton mill), Bay State, Conqueror, Williams, Dunham, Jack Possum, Enochs, Webster, Omega, and Grace; also the Connecticut and Pearl tailing mills.

The production from the St. Louis-Joplin Lead & Zinc Co.'s land was much less than in 1912, as the mill at the A. B. C. mine was destroyed by fire. A new mine was opened up by the Kentucky Lead & Zinc Co. on the Putnam lease, but all the output in 1913 came from the A. B. C. and the Joplin-Kentucky mines, each of which was equipped with a 150-ton plant. Considerable churn drilling was done which is said to have shown large ore bodies on the SW. $\frac{1}{4}$ sec. 32 (southwest 40) and the SE. $\frac{1}{4}$ sec. 32 (southeast 40).

Two new mines operating in "sheet ground" on the Expansion Realty Co.'s land in the west Joplin field in 1913 were the Otis Mining Co. and the Hoo Hoo Mining Co., but the output was small. At the Otis mine the shaft was sunk 180 feet and a 250-ton mill driven by electric power was built. The old Hero mine on Banner Investment Co.'s land, operated by W. O. Cragg & Co., was one of the largest producers of concentrates from "sheet ground." Steady development work opened up a face of ore about 300 feet long and 10 to 15 feet high. The mill has a capacity of 150 tons.

The Luke land adjoining was drilled by the A. W. C. Mining Co., a shaft was sunk to the ore body in the "sheet ground," and a concentrating plant was built. As the mill was only operated for a brief period in 1913, the output was small.

One of the favorable features of the year was the large production of galena and blende from "sheet ground" ore opened on the Continental Zinc Co.'s land. The yield of galena gave the Continental land first place for lead production. The "sheet ground" on the tract was mined by Allington & Cristy by means of shafts 195 and 205 feet deep on the Thornton lease. The dirt was concentrated at a 200-ton plant. The other large producing leases on the tract were the Jack Harvard equipped with a 150-ton mill, and the Bippo (Kohinoor), which has a 200-ton plant.

Both "sheet" and "soft" ground was mined on the Lambert-Reisling land. The output was large until the Waneta mill on the Osceola lease was burned in August.

A newly developed mine on the Irwin land at Central City, leased to Thomas Douglas, made a good output of sphalerite from very rich dirt treated by means of hand jigs.

South of Central City in the Gordon Hollow Camp, one of the largest producers was the Hillside Mining Co., mining on the Ten Per Cent Prospecting Co.'s lease of the Murphy land. The Hillside Mining Co.'s mill of 100-ton capacity was operated steadily on dirt mined by the company and by other lessees on Murphy ground. Several of the adjoining leases were purchased by the Hillside. The ore body, while not exceedingly rich, is of good size and cheaply mined, making operation profitable even at the lower prices for ore.

The property of the Gordon Hollow Land & Mining Co. was acquired by Wm. Foss and many improvements were made underground and in surface equipment. Three mills, the Puritan of 150 tons, the Niagara of 150 tons, and a custom mill of 125 tons, were operated on ore taken from 10 shafts from 30 to 120 feet deep. Other productive properties at Gordon Hollow were the Betsey on Scotia Mining Co.'s land, lessees on the H. H. Gregg land, Purciller Mining Co. on Mattes Bros.' land, and lessees of the General Lead & Zinc Co.

The Midway tract of the American Zinc, Lead & Smelting Co. was a large producer of sphalerite. Two of the principal producers were the Sapulpa or Tecumseh mine and the Producers Mining Co., which erected a 150-ton concentrating plant in 1913. The Lee Hall, B. C., and Red Lion mines on the Anderson-Norton land made a good production of sphalerite. The average depth of mining was 165 feet, and three concentrating plants were operated, one of which, the Red Lion, was rebuilt after being destroyed by fire.

Other large producers of sphalerite were the Dirigo Land & Leasing Co., Burke & Co., and the Junior Mining Co. on the W. E. Johnson land; Homer Seals and Dodson & Co., on the Montgomery land; lessees of the Paoma Mining Co.; Little Martha Mining Co., on the Pittsburgh-Missouri Zinc & Lead Co.'s land; the Greencastle, Jasper, Tom C., Schnur & Co., and Watson & Co., leases on the Rex land; lessees on the P. L. Swartz land; and lessees of the United Zinc Co.

The principal shippers of zinc silicate and carbonate and lead carbonate were lessees of lands belonging to the Shoal Creek Mining Co., Saginaw Investment Co., A. E. Spencer (Mossback land), Roaring Springs Mining Co., Owensboro-Joplin Mining Co., Missouri Lead & Zinc Co., Atchison Mining & Milling Co., L. B. Jones, Willard L. Butts, and German-American Mining Co. Production of either lead or zinc concentrates was made in 1913 by the following: Geo. R.

Berry (Leckie land), Mack & Co. (Baker land), Crellar Land Co., A. S. Baldry & Co., O. E. Foster, lessees of B. F. Cox, Old Jordan Mining Co., Henry Weymann (Gray land), R. W. Latshaw & Co., Hecma Land & Mining Co., Home Land & Loan Co., Keller Realty Co., lessees on the James Leonard land, Marion B. Mining Co. (Henderson land), C. H. Montgomery, Geeding & Grannis (tailing mill), Beacon Mining Co., H. J. Krugg (Robb land), J. E. Aldrich (Spencer land), Old Dominion Mining Co. (Taylor land), South Joplin Lead & Zinc Co., and Dunnigan & Co.

Oronogo district.—In 1913 the production in Oronogo district of lead concentrates decreased 270 tons and of zinc blende concentrates increased 1,008 tons as compared with the output in 1912. Most of the producing territory in the district has been owned for many years by the Granby Mining & Smelting Co. Little of the "dirt" came in 1913 from workings above the 70-foot level and nearly all of the production was made by three or four companies. The most prominent producer on Granby land was the old Oronogo Circle mine, which had a larger output of blende concentrates than any other mine in Missouri. Four shafts of 160, 240, 230, and 230 feet, respectively, were operated in 1913, and the ore was concentrated on the large mill having a capacity of 1,000 tons every 24 hours. Complete electrical equipment was installed to replace steam as power. Various improvements for the more rapid and economical handling of the ore were made. Steady development work on the 126-acre lease is said to have opened large bodies of ore sufficient to supply the mill for a long period.

The Pinnacle Mining Co. had on the Granby land two 235-foot shafts in operation and produced a large output of both lead and blende concentrates. The concentrating plant has a capacity of 250 tons. The only other large producers on Granby land in 1913 were the New Year Mining Co. and the Morning Star Sludge Co.

Sarcoxie-Reeds district.—The production of this district, which was entirely of zinc blende and zinc silicate in 1913, was more than five times as large as it was in 1912. Most of the increase in zinc blende was the result of the working of a new mine by the Reo Mining Co. on the Mercantile Metal Milling Co.'s land, situated 3 miles west of Sarcoxie. A large output was made from ore mined at the 90-foot leval by means of a 150-foot shaft. The 125-ton concentrating plant is equipped with 3 tables, and the zinc content of the sphalerite averages nearly 61 per cent. Very little ore was mined from the Henry B. Boyd land, though the Optimo mine and 200-ton mill was operated by Thompson & Co. The Cameron mine and mill on the J. W. Boyd land was leased and operated by the Bear Cat Mining Co. and yielded an output second to that of the Reo Mining Co. The zinc silicate production was mined by Harvey A. Cale and Edward Grieb.

Thoms Station-Sherwood district.—In 1913 this district produced 480 tons of lead concentrates and 4,474 tons of blende concentrates more than in 1912 and advanced from fifth to fourth place amongst southwestern Missouri districts. The output of lead concentrates in 1913 was 1,432 tons, valued at $75,480, and the output of zinc blende concentrates was 21,700 tons, valued at $774,180. The percentage of concentrates in the "dirt" milled was higher than in the other Missouri districts. The active development which commenced late in 1910 continued throughout 1913. No similar area in Missouri

was more actively explored with drills. Several new concentrating plants were built and operated and others were under construction. The ore being located at comparatively deep levels in very soft ground made shaft sinking and the opening of the mines a work requiring extra care and time.

The largest producer of galena in the district was the Napoleon mine and more than half of the sphalerite concentrates were produced from the Pocahontas and Powhatan mines. The Pocahontas mine on the Murphy land was one of the largest producers of sphalerite in the Central States in 1913, and its output was exceeded by the Oronogo Circle and the American Davey mines only. The average recovery of concentrates from "dirt" ran over 10 per cent, being practically all sphalerite with a very small quantity of galena. Two shafts were used to hoist ground from levels about 180 feet deep. Shaft No. 2 was sunk 460 feet north of the mill and a Leschen aerial tram was constructed connecting this shaft to the mill, which is electrically driven and has a capacity of 200 tons. The Powhatan mine is on the Madison Land & Mining Co.'s land, a short distance from the Pocahontas, which it resembles in formation and the nature of its output. A 200-ton mill was erected in 1913 and one 180-foot shaft was in operation and another was being sunk. The output of the Sitting Bull mine on the Brinkerhoff land was only about one-half of what it was in 1912. The 200-ton mill was not operated steadily but considerable drilling and prospecting was done on the lease and it is reported that another extensive ore body has been blocked out. The Mary E. mine on the same land was abandoned and the Beatrice B. output was confined to a good production of galena and a small yield of sphalerite recovered prior to June, 1913.

The Mexico-Joplin Land Co. owns 560 acres of land upon which many lessees were working, but their combined output was very much less in 1913 than in 1912. Twelve shafts were in operation, by means of which ore was hoisted from depths of 145 to 200 feet. Six concentrating plants, having an average capacity of 150 tons, were operated at intervals during the year. The productive leases were the Shiney Bill, Mohawk, Bull Durham, Blue Jay, Mary C., High Tariff, Emma A., and Sweetheart; and the Katy and Sunny South mines were under development.

A large part of the output from the land of the Hancock-Connor Realty Co. came from the Jungle mine, which was closed down in July, 1913. The only concentrating plant on this tract is one of 200 tons capacity at the Jungle mine. Seventy acres of the tract were leased by the Thornton Mining Co., the Silver Lake Mining Co., and other lessees which were small producers.

The production from the Thoms Station tract of the Sheridan-Adams Royalty Syndicate more than doubled in 1913 and development work was more active than usual, the low ore prices being considered. Some galena was mined at the shallower levels from 100 to 150 feet, and most of the sphalerite was derived from levels having an average depth of 180 feet. There are three mills on the land, the Ortt & Coats of 150 tons' capacity, now owned by the Voegel Mining Co.; the Vinegar Hill of 150 tons capacity, owned by the Hardy Mines Co.; and the Pocatello of 200 tons capacity. Two mills, the Ortt & Coats and the Pocatello, were built in 1913. In addition several

hand jig plants made a good output of both lead and zinc concentrates.

The Betsey Jane 100-ton mill on the Spencer & Lloyd land was run partly on ore from the Betsey Jane mine, but mainly on ore mined by the Home Development Co. on the adjoining Evans land. The 150-foot shaft on the Evans land is situated about 200 feet from the Betsey Jane mill and an elevated tramway was used to convey the ore from the shaft to the concentrating plant. The Texas Mining Co. also operated on the Lloyd & Spencer land and made a good production of sphalerite from the 160-foot level in "soft ground." The 125-ton mill was erected in 1913.

The Durston Mining Co.'s lease on the Rusk land was subleased to the Kansas City Zinc Co. A fair output of both galena and sphalerite was made. The Napoleon mine on the Perry land, after an extensive drilling campaign, sunk two shafts and completed a 150-ton concentrating plant driven by electric power. The ore body is said to be large and to average over 8 per cent in concentrates. The quantity of galena recovered in 1913 was much greater than from any other mine in the district. Over half the value of the concentrates sold was for lead, though the production of sphalerite was only exceeded by three mines in the Thoms Station district. Only one shaft on the property of the Alamo Land & Mining Co. was operated in 1913. This was on the Bearden lease, which is equipped with a 100-ton electrically operated mill.

Other smaller producing properties in the district in 1913 were the Dutchman's Dream Mining Co., Waneta Pearl Mining Co., Mary B. Mining Co., Lagonda Lead & Zinc Co., Captain E. Mining Co., Excelsior Zinc & Lead Co., Frisco Mining Co., Cactus Hills Mining Co., Ornduff & Co., Francis T. Mining Co., C. H. & Y. Mining Co., Valentine Mining Co., W. H. Yankie, and the Lawson-Cameron Mining Co.

Spring City-Beef Branch district.—The production of galena and sphalerite concentrates in this district increased considerably in 1913, and the total value of the concentrates sold was only about $3,000 less than in 1912. There was a decided revival in mining development, old properties were reopened, and new lands were prospected outside of former proved mineral areas. The production of galena concentrates in 1913 increased 1,073 tons and that of sphalerite 598 tons. The production of lead carbonate decreased 121 tons and that of zinc silicate and carbonate 1,103 tons. Lessees on the Adam Scott lease of the McCown land produced only a small quantity of concentrates classed as zinc silicate, but the output of galena and sphalerite was nearly half of the entire yield of concentrates from the district in 1913. The most productive lease was that of the Delta Lead & Zinc Co., operating the Delta, Platta, and Halloween mines. The ore was hoisted from levels between 170 and 200 feet. The 150-ton mill was overhauled and other surface improvements were made. The product recovered was galena and a mixed concentrate of sphalerite and zinc silicate, averaging 48 per cent zinc content. The Spring City Lead & Zinc Co.'s plant on the McCown land was moved to a new part of the lease and a fair output of galena and blende was recovered, also a small production of zinc silicate. The Sunrise, Lone Hickory, and Fairview mines on the J. W. Allen land made the largest

tonnage of zinc silicate and carbonate in addition to a large output of galena and sphalerite. On the Lone Hickory there are 2 shafts and a 75-ton mill. The lease was purchased by M. Roff in 1913 and the mill was run on tailings. Most of the production from the Allen land was from the Sunrise lease of the Minor Heir Sunrise Mining Co., which is equipped with a 150-ton mill. The Wise & Co. lease on another tract of the Allen land was thoroughly prospected and several shafts were sunk. A large quantity of ore was hoisted and placed on the dump, and the property was then transferred to the Anna Lee Mining Co., which continued development and contracted for a large concentrating plant, which was in course of erection late in 1913.

Most of the production from St. Paul Mining Co.'s land was that of Bailey & Johnson, who opened up a rich deposit of galena and zinc silicate at the 150-foot level. Much of the dirt contained large pieces of free ore which was hand cobbed, and the finer dirt was cleaned on hand jigs. The westerly 40 acres, adjoining the Bailey & Johnson lease, was drilled and the Black Hawk Mining Co. appear to have found good ore.

On the Zeta Land & Investment Co.'s property the Lu Lu V. Mining Co. deepened an old shaft to 180 feet and erected a 150-ton concentrating plant. The mine was the second largest producer of galena in the district in 1913, and also yielded a good output of sphalerite and some zinc silicate. The only production from the Bales land was of zinc silicate from the Ginrick lease.

The Cooper & Kelly land was mined by the Sabbath Mining Co. until May. Four hand jigs were used to concentrate ore mined at a depth of 70 feet. Fairly large yields of zinc silicate were reported from the Doane & Son and B. D. Mowry leases of the Henry Weymann land, from the Georgia Mining Co., the T. J. McKenney lease of the Hoge land, and the Clark Craycroft lease of the Leake land. The bulk of this class of zinc concentrates was derived from ore bodies found between 40 and 90 feet in depth.

The Onondaga Mining Co. production was very small in 1913 and the Bedell land, on which 1,500 feet of drilling was done and a shaft was sunk by W. L. Kepner, reported no output.

Springfield district.—A large part of the production given in the Missouri table for 1913 for the Springfield district represents the output of the Bray Mining & Milling Co., located on Pierson Creek, 5 miles southeast of Springfield. This company reopened the Daisy mine in the latter part of 1910 and has operated it steadily during the years 1911, 1912, and 1913. A new shaft was sunk 140 feet and many surface improvements were made. It was reported that by churn drilling a new run of ore was found which is 500 feet long, 12 to 50 feet in width, and about 15 feet in heighth. The ore deposits are in channels mixed with gumbo and in sheets in the roof, which is blue shale. The "dirt" or ore was dressed in a 50-ton concentrating plant and yielded over 8 per cent of concentrates. The average metal content of the galena concentrates recovered was over 83 per cent and the average zinc content of the blende concentrates was between 63 and 63.5 per cent, with very little iron.

No concentrates were shipped from the Badger mine of the Choteau Mining & Land Co., but a new shaft was being sunk.

The Clark Mining Co. hoisted ore through two shafts from the 65-foot level, which was concentrated by hand jigs. Parker & Cook opened a mine on the McFarland land 3 miles southeast of the Bray mine and erected a 100-ton concentrating plant, which was not completed until 1914. The ore body mined lies at the 40-foot level.

Spurgeon-Seneca district.—The total value in 1913 of the lead concentrates produced in this district was $6,580, a decrease of over $26,000, and the total value of the zinc concentrates was $73,789, an increase of over $43,000, compared with 1912 figures. The value of the lead output from the district has decreased over $45,000 during the last two years and the value of the zinc concentrates has increased over $63,000.

Most of the zinc blende concentrates came from the Quaker Maid mine, though some of the production was shipped by the Owl Mining Co. and lessees on the Newman land.

The Quaker Maid Mining Co., which is now owned by Geo. D. Lord & Co., had 3 shafts 85 feet deep in operation, one of which was being sunk to a lower level. Improvements were made to the surface equipment and to the 100-ton mill. The Owl Mining Co.'s mine and 150-ton mill on the Aylor-Olson land was only running during the first 5 months of 1913. A good output of galena and sphalerite was derived from the Newman land by Woods, Vader & Co. The land was subsequently leased to Maher & Co., who are sinking a new shaft so that ore can be mined from the 90-foot to the 100-foot level. All the concentrates recovered in 1913 were treated by means of hand jigs. The H. E. Bucklin land was leased to the Blue Bird Mining Co., which obtained some blende from a 50-foot shaft. Only galena was produced by J. & C. Craig on the Granby land and by the Lynette Mining Co., on Gallemore land.

Stotts City district.—There was no work of any importance done in this district, and as the only production was a small quantity of blende derived from tailings on the Green B. Stott land, the output is included under that of the Wentworth district. The old Gundling mine was sold to the Lawrence Land & Mining Co., and by it leased to J. M. Short, who did no mining in 1913.

Wentworth district.—The value of the production of zinc concentrates in this district decreased from $86,673 in 1912 to about $39,000 in 1913. The output was composed of blende and zinc silicate in nearly equal quantities. The largest producer was the Blue Bell Mining Co., on the Wentworth Land & Mining Co.'s lease of the Smith land. The Blue Bell mill of 150-tons was the only concentrating plant on the lease, as the Alice Dayton mill was destroyed by fire. The old Mocking Bird or Nancy Jane mine was operated by Lange & Co., and yielded about half of the zinc silicate reported from the district.

Wetherill and other districts.—The production given in the Missouri table includes the output from the Wetherill district in Howell County and that of a few mines in Taney County adjoining. The output was entirely zinc carbonate, most of which was derived from the Alice mine, of the Empire Zinc Co., near Wetherill. The ore, which is carbonate of zinc carrying limonite, crops out at the surface and is worked down to a depth of 70 feet in a large open pit at the bottom of which ore is still showing. The zinc carbonate is cleaned

in a log washer having a capacity of about 150 tons per 10-hour shift, which was operated from May until December in 1912.

The producing mines in Taney County were those of A. Arnold, near Ozark; the old Silver Moon mine now owned by the Melva Mining & Milling Co., near Melva; and the L. H. De Mill & Co.'s mine on the Richardson land, near Hollister. The combined output was not large, but it was the first ore shipped for several years. The Arnold land has been leased to F. A. Curnow & Co., and a steam concentrating plant of 60 tons capacity has been erected. Considerable development has been done by means of tunnels, open cuts, and shallow shafts.

Webb City-Carterville-Prosperity district.—This district includes most of the original and typical "sheet ground" territory, and the low prices paid for zinc blende concentrates during 1913 cut off production entirely from some mines in the district. In other mines it caused a lessened yield by the resumption of single-shift working in place of the abnormal rush to make high-priced concentrates that prevailed in 1912. The average recovery of galena and blende concentrates from crude ore mined from "sheet ground" has been 2.6 per cent for the last four years. It is generally believed that most mines having ore that yields between 2 and 2.5 per cent in concentrates can not be profitably operated when blende concentrates sell for less than $44 or $45 per ton. In the natural course of mining the ore bodies in some mines were exhausted, and a few new "sheet ground" mines were opened to make up the lessened output.

The pulling of the large pumps from the Yellow Dog mines, where the ore body had been worked out, threatened the existence of the mines working the lower levels in the North Webb City district. It was difficult to induce cooperation in pumping on account of the depressed ore prices, but an arrangement was eventually made by which the mines and landowners benefited contributed part of the cost of operating the large pumping plant at the Providence mine. The present depth of the water level does not permit operations in some of the lowest levels, but the pumping now done does prevent the water from stopping the operation of many mines. Only a very small percentage of the district production is derived from "soft ground," and the prominence of the "sheet ground" mining is indicated by the fact that about 76 per cent of the total production of crude "sheet ground" ore came from this district. The recovery of galena concentrates in southwestern Missouri from ore mined in "sheet ground" was 20,389 tons, of which this district produced 17,294 tons. The quantity of zinc blende concentrates in southwestern Missouri derived from ore mined in "sheet ground" was 92,912 tons, or over 42 per cent of the total zinc blende output of the entire State, and of this large quantity the "sheet ground" mined in the Webb City-Carterville-Prosperity district yielded about 66,124 tons, compared with 94,570 tons in 1912.

The total production of lead concentrates in this district in 1913 was 21,771 tons, or 2,344 tons less than in 1912, and the value decreased $223,927. The production of zinc blende concentrates in 1913 was 77,469 tons, a decrease of 24,149 tons when compared with the output of 1912. The total value of the concentrates sold was $4,298,544 in 1913 and $6,522,781 in 1912. The production from "soft ground" mining in the district showed an increase of 1,747 tons of galena and of 4,297 tons of sphalerite.

Lessees on the Guinn land reported the largest output of both lead and zinc concentrates in the district. The capacity of the 12 concentrating plants on the land was in excess of 4,000 tons per day. The leasing companies that produced in 1913 were as follows: Electrical Lead & Zinc Mining Co., Hurry Up Mining Co., Mercantile Metal Milling Co., Ice Plant Mining Co., Rhea Lead & Zinc Co., Mutual Lead & Zinc Co., Show Me State Mining Co., J. P. Royalty & Mining Co., Mont B. Mining Co., Daniels Bros., and Walker & Co. One of the largest producing companies on the Guinn land was the Mercantile, which operated mills Nos. 4 and 5, each of 250 tons capacity, and mill No. 1 of 200 tons capacity. The Electrical mine and 150-ton mill were leased to the Incline Mining Co. during the year. The Schoenheuer-Walton mine on the Rhea lease made one of the largest outputs on the tract. Nearly all the ore milled on the Guinn land was derived from "sheet ground" between 173 and 210 feet.

The Davey tract of the American Zinc, Lead & Smelting Co. produced the second largest output of galena concentrates and of blende concentrates in 1913. The Davey mines Nos. 1, 2, 3, and 4 are in the vicinity of Prosperity and are equipped with 4 double-compartment shafts from 225 to 250 feet deep and 4 concentrating plants having a combined daily capacity of over 3,500 tons. Electric power is used at all the plants, and there is a separate plant for the treatment of slimes at Davey No. 3. The production from the Davey mines was considerably less than in 1912, but in quantity and value was greater than any other single company's production in southwestern Missouri. The Richland and Hockaday tracts belonging to the same owners made a comparatively small output.

The lessees of the Center Creek Mining Co. in the territory between Webb City and Carterville were the fourth largest producers of concentrates. The principal producing lease on the Center Creek Mining Co.'s land was that of S. Y. Ramage, who hoisted ore through 2 shafts and milled it on 2 concentrating plants, having a total capacity of 550 tons. This lease (Morgan 40) has been one of the largest producers in the district for many years, and the mining plant, to which some slime tables were added, is modern in every respect. No. 2 mill was in operation only for a part of 1913, and probably will be run on the large pile of tailings that has accumulated on the lease.

Other producers on Center Creek land were the Laura Alice Mining Co., Comanche Mining Co., Pacific Sludge Co., Pioneer Mining Co., Four Dogs Mining Co., Central Mining Co., Wisby & Co., and Spotted Dog Mining Co. About 18 shafts were in operation, and the 9 concentrating plants had a combined capacity of 1,300 tons. The mines on Center Creek Mining Co.'s land have produced several million dollars worth of ore and the land has been continuously worked for many years. The depth of mines varies from 25 to 150 feet, and the production from leases other than the Ramage was larger in 1913 than in 1912.

The lessees of the Bradford & Kansas City Zinc Co. in the same locality as the Center Creek mines also reported a large production. The sublessees were the Dinger Mining Co., Empress Mining Co., Lancaster Mining & Milling Co., and the Beulah S. Mining Co. Four shafts were worked and the ore was milled at two plants, having a

total capacity of 550 tons. The power used at the Lancaster mill was changed from steam generated by gas to electricity.

The Continental Zinc Co. produced large quantities of both lead and zinc concentrates from the Litteral tract at Prosperity. One double-compartment shaft 210 feet deep and a 350-ton mill were operated steadily throughout the year. The Lucky Budge, Dominion, and Avondale leases on the Prosperity 40 of Ben C. Aylor made a good output. There were two concentraing plants on the lease having a combined capacity of 300 tons.

The production of galena from the Connor Realty Co.'s land was larger in 1913 than in 1912, but the sales of sphalerite decreased. The most productive leases were the Sara and the Federated. The ore mined by the Federated was milled at the M. S. mill, which has a capacity of 200 tons.

The only mill operated on the Ashcraft 40 was the 250-ton plant of the Providence Mining & Milling Co. A good output was made, though it was smaller than in 1912. Seven shafts were operated in sheet ground at 170 feet. Providence No. 2 on the Missouri Zinc Field Co.'s land was not operated, and the only output from the land was made by a 75-ton custom concentrating plant.

The Portland Lead & Zinc Co. opened a new mine in "sheet ground" on the Cunningham land near Carterville. The shaft was sunk 217 feet, and a 300-ton concentrating plant was erected. The mill was not ready until late in the year, so that the output was comparatively small.

Many of the large "sheet ground" mines are directly north of Webb City. A large proportion of the production for the district came from leases on the Kelly; Bowman, Scott & Ware; Newell Morse Royalty Co.; Byrd; Baker; Pike Land Co.; Rochester; and Underwriters Land Co. properties. Among the producers on the Kelly land were the White Dog, Osceola, Imperial, and Mineral King mines, and a new 250-ton mill was erected at the Imperial mine. Four shafts were utilized to hoist ore from "sheet ground" at levels from 165 to 212 feet deep. The largest producers were the White Dog and Osceola mines. The combined capacity of the 4 concentrating plants operated in 1913 was 800 tons per 8-hour shift. Only two tracts of mining land in the district had a larger output of galena and sphalerite concentrates than the Bowman, Scott & Ware land, on which 3 concentrating plants of about 300-ton capacity per 10-hour shift each were operated by the Carmean & Squire Mining Co. (Genessee mine), Herbert S. Mining Co., and the Wingfield Mining Co. A sludge plant was also operated by the Leona Mining Co., a sublessee of the Carmean & Squire Mining Co. All of the lessees were mining "sheet ground" at about 200 feet, and the mines were very productive. The Wingfield Co. used 3 shafts to hoist ore, increased the capacity of the mill, and made many surface improvements.

The producing leases on the Newell Morse Royalty Co.'s land were the Athletic and the Bertha A. The Athletic mill, which had a capacity of 400 tons single shift, was destroyed by fire in September, but the Bertha A. plant was operated steadily. A new sludge plant containing 8 tables operated by electric motor was built in 1913, and many improvements were made to the Bertha A. mill. There are 5

shafts at the Athletic mine and 3 shafts at the Bertha A. mine, all used to mine "sheet ground" at a depth from 217 to 223 feet.

The output of concentrates on the Byrd land came from the Goode, Old Dominion, Charleston, and Morning Star mines, and was slightly less than in 1912. The Nowata mill was removed from the Pike Land Co. in September, 1913, and the tailing mill of the Mary Milling Co. was burned, so that the output made by the lessees was considerably less than in former years. The Underwriters Land Co. fee and their lease of the Worthington land yielded a quantity of both lead and zinc concentrates. No deep mining was done on the land held in fee after June, 1913, and the pumps were pulled, allowing the water to flood the mine. The output of lead made was mostly obtained by the Old Staple Mining Co. by means of two 50-foot shafts. The Vantage Mining Co.'s lease on the H. M. Baker land was operated by the Vantage Extraction Co. and sublessees. A good production of concentrates was made. The Minor Heir Mining Co. made extensive improvements to the 150-ton mill on the land and constructed a tramway from the mill to the bottom of a large open cut caused by the caving of the old workings. In addition to the open-cut mining by the Minor Heir, 2 shafts 60 feet deep were worked by other lessees.

Other shipments of concentrates in 1913 were made by lessees of the Rochester Land & Leasing Co., Boston Get There Zinc Co., Dougherty & Davey land, O'Neill land, Reagan land, Bendelari Land Co., General Lead & Zinc Co., Carter land (Laminite), Carterville Mining & Smelting Co., Eleventh Hour Mining Co., and by W. E. Saum and the Sunflower Lead & Zinc Co. The Sunflower 300-ton mill was destroyed by fire in April and made a much smaller output than usual.

Zincite-Smithfield district.—The mines in this district include those in the territory from south of Zincite along the western border line between Missouri and Kansas to the north of Smithfield. The production of zinc concentrates in the southern portion of the district increased about 500 tons in 1913, and that of the northern end of the field near Smithfield increased about 3,300 tons.

The total yield of sphalerite in 1913 was 8,577 tons, valued at $341,634, compared with 4,716 tons, valued at $265,144, in 1912. The shipments of galena were 26 tons more than in 1912. Although the northern part of the district was active, no large producing properties similar to the Yellow Jacket and Yellow Pup were developed. Mining in the former rich shallow fields near Belleville in the southern portion of the district was stimulated by the prevailing ore prices. Many new leases were made on old mining tracts, so that the production from the southern part of the district will probably increase in 1914, while that from the northern part may be smaller than in 1913. The Yellow Jacket mine on the McBee land made a large output of high-grade sphalerite until the workings, which were in very "soft ground," caved. The 200-ton mill will likely be moved, though it is reported that drilling on the land which was purchased by the Underwriters Land Co. has shown other ore bodies. The Aberdeen Mining Co. which is also on the McBee land made a larger output in 1913 than in 1912. The 150-ton mill was run steadily on good ore hoisted through a 130-foot shaft. The Yellow Pup mine on

the J. T. Lafferty land was much the largest producer in the district and one of the largest in the Joplin region. The dirt yielded about 8 per cent in sphalerite of good though not high grade. The shaft at the Yellow Pup mine is 100 feet deep, and the electrically operated concentrating plant has a capacity of 200 tons.

The Minor Graham Mining Co., lessee of the Parkinson, Graves & Harper land and of the 150-ton mill at the Clara Belle mine, was the largest single producer in the southern part of the district, but the mine was closed down the latter part of 1913. The only productive lease on the Belleville Land & Mining Co.'s property was the Dorothy Marie, where a fair output was recovered from ore taken from an open cut.

The Seven, Baby Ruth, and Pussafiss mines on the Capitalista Mining Co.'s lease of the Cragin & Staples land produced a large quantity of high-grade sphalerite and some galena from five shallow shafts. Some of the dirt was treated on a 75-ton mill and part by means of hand jigs.

The New England Zinc Corporation purchased the lease of the Kidd Mining Co. on the Edwards land late in 1913, and several lessees produced lead and zinc concentrates. The property is equipped with a 150-ton mill. The Powers Mining Co.'s lease on the Wm. Leckie land produced a good yield of 63 per cent sphalerite. One shaft was used to mine ore at the 165-foot level, which was concentrated at a 100-ton mill. The Kirkwood Mining Co. subsequently purchased the mine and mill.

The richest dirt mined in the district in 1913 was that mined by Peters, Dooley & Co. from the H. C. Murphy land. The mine was opened late in 1913 but a good output was made.

Other producers in the district in 1913 were Campbell & Co., Stoney & Co., lessees on the Davidson land; Stump Mining Co., O. D. Bittick, Cook & Co., and Mosbaugh & Co. on the Llewellyn land; Bailey & Co. on the F. R. Brooks land; and various lessees on the A. M. Brooks and A. B. Brooks land. The O'Keefe land was drilled by L. E. Holden and the Fisher land by Franklin Smith & Co. On both lands satisfactory cuttings were obtained but no output was made.

CENTRAL AND SOUTHEASTERN MISSOURI.

The ore deposits of central and southeastern Missouri reach in a more or less connected belt from the region of Benton, Pettis, Morgan, Moniteau, Cole, and Miller counties on the northwest to the northern and eastern flanks of the St. Francis Mountains on the southeast. It is also true that there are scattered areas where more or less mining has been done all the way between the northwest end of this belt and the Joplin region, so that strictly speaking the lead and zinc deposits of Missouri practically form a zone around the northern half of the Ozark dome.

The deposits in the counties named above, corresponding to the central Missouri region, are of the general type of those in the Joplin region, in that the ores consist of galena and sphalerite, or the oxidized derivatives of those minerals, and occur in association with solution breccias and sink-hole shale patches, the ore being found in the Cambrian and Ordovician dolomites and included cherts and occasionally in the Pennsylvanian shale. The occurrence of ore in

crevices or thin vertical sheets is very common, but practically all the production of ore has been obtained from sink-hole breccias or "circles," a form of deposit noted as also important in the southwestern Missouri area.

The southeastern part of the belt, in the vicinity of the St. Francis Mountains, forms the disseminated lead region of southeastern Missouri. The southeastern Missouri deposits have been known and worked for about 200 years. The earlier workings were shallow, and even yet considerable shallow lead is raised, generally in connection with the mining of barytes, or "tiff," as it is locally known. The mines in the disseminated lead region range from 100 feet to about 550 feet in depth, depending on the depth from the surface to the basal portion of the Bonneterre limestone.

The ore deposits now worked are almost wholly in the lower part of the Bonneterre limestone, where they occur in disseminated form over large areas, relatively richer in the vicinity of the intersecting crevices and joints. The crevices show little if any displacement, and there are no breccias of consequence. The copper, nickel, and cobalt in Madison County occur with galena and marcasite in blanket formation in the carbonaceous beds of parting at the contact of the Bonneterre limestone with the Lamotte sandstone below, and in the vicinity of the intersection of this contact with the sloping surface of the pre-Cambrian rocks. Both the Bonneterre and the Lamotte formations are of Cambrian age.

Prospecting is done by means of the diamond drill, and extensive campaigns of drilling have been prosecuted in the vicinity of all the important producing tracts.

The diamond drill is also used in mining as an aid in following the ore. Cores are taken from the heading in various directions, straight ahead, at angles upward, downward, or to the side, and from these cores the direction to drive the heading is determined.

The ore in the southeastern Missouri region is almost wholly lead, although a considerable zinc deposit occurs at Valle mines, some 6 miles north of the Bonneterre district. A certain percentage of zinc is also found in the disseminated lead ore, the ore from one shaft being reported to run occasionally as high as 2 per cent of zinc for a week at a time. The zinc occurs more plentifully in the Leadwood-Flat River districts, and may lie near the contact of the Bonneterre limestone with the Lamotte sandstone or some distance above it. In the lead concentrates zinc ranges from 1 to 5 per cent or more. In the maximum proportions mentioned the zinc makes trouble in lead smelting, and for this reason some of the concentrating plants remove the zinc as a table middling. An interesting feature of the zinc middlings is that they carry a disproportionately large part of the silver content of the ore, the silver being apparently associated with the zinc rather than with the lead.

Copper, nickel, and cobalt also occur in the ore, in greater quantity in the vicinity of Fredericktown, and in small quantity, irregularly, in nearly all the deep mines. It is only near Fredericktown that the copper, nickel, and cobalt content of the ore has been the object of mining, yet a concentrate of these metals has been recovered as a table middling at several plants in other parts of the district, and in some instances has been a source of income.

The lead ore of southeastern Missouri carries a small proportion of silver, the average being a very little over 1 troy ounce to the ton of lead concentrates. The resulting pig lead likewise carries silver, together with a little copper, nickel, cobalt, and traces of antimony and arsenic, and is sometimes commercially known as "Missouri chemical" lead in contradistinction to "Missouri soft" lead from the Joplin region. An average of about 15 per cent of the total lead concentrates from southeastern Missouri is desilverized. The silver so recovered does not pay for the refining charges, but the desilverized lead commands a slightly higher price, making up the difference. As the silver content of the concentrates is so small it is disregarded in their sale, and therefore the smelter reports are relied upon for the silver production. As already explained, the quantity of silver produced during any year bears no direct ratio to the quantity of silver-bearing lead concentrates smelted during that year, for the reason that the silver bullion is stored and refined in batches at convenient times.

The silver output of Missouri in 1913 was derived almost entirely from lead concentrates, the only other source of production being a small quantity of sorted copper ore shipped by the Cornwall Mining & Smelting Co. to Omaha for smelting.

The silver production of southeastern Missouri was 35,620 fine ounces in 1913, as compared with 35,438 fine ounces in 1912, 49,867 fine ounces in 1911, 33,096 fine ounces in 1910, 14,188 fine ounces in 1909, and 49,131 ounces in 1908. The silver production of 1913 was recovered from 35,854 tons of lead concentrates and from copper ore that averaged 0.38 ounce per ton; that of 1912 was recovered from 31,183 tons of lead concentrates; that of 1911 was recovered from 51,109 tons; that of 1910 was recovered from 35,002 tons; that of 1909 from about 31,000 tons; and that of 1908 from 26,488 tons.

The crude lead ore mined in 1913 amounted to 4,250,800 short tons, against 4,064,366 tons in 1912 and 3,974,712 tons in 1911. The crude ore in 1913 yielded 5.15 per cent of lead concentrates, which averaged 67.2 per cent of lead. The average value per ton of the lead concentrates in 1912 was $43.63, as compared with $45.01 in 1912, and the concentrates were slightly higher in lead content than in 1912. The output of galena concentrates was 218,803 tons, valued at $9,849,854 in 1912, and 219,511 tons, valued at $9,580,893, in 1913. As several of the large producers not only mine but also smelt their lead concentrates, the values given for concentrates are arbitrary to a certain extent. The galena concentrates produced in the southwestern Missouri region containing a higher lead content are mainly sold on bids from various purchasers, and the lead concentrate prices are not comparable with those given for the disseminated lead district.

The production of sphalerite from central Missouri in 1913 amounted to only 33 tons, valued at $574, which was slightly less than in 1912. The production of zinc carbonate from southeastern Missouri in 1913 amounted to 639 tons, against 1,051 tons in 1912. Labor troubles in the "disseminated lead" district caused considerable expense and loss of time before they were finally settled.

REVIEW BY COUNTIES.

Pettis County.—The Camilla Mining Co., on the Chester Realty Co.'s land in sec. 27, T. 44, R. 20, Pettis County, sold a quantity of galena concentrates. The ore deposit is in limestone with a spar gangue, the lead content being much greater than that of zinc. There are two shafts at the mine, one 96 feet deep and the other 130 feet deep.

Benton County.—The Tahoma mine, which is equipped with a 200-ton concentrating plant, was purchased by the United Zinc & Barytes Co. Some ore was hoisted and milled, but the concentrates were stored pending treatment for the removal of the barytes by a newly patented process. The product was galena and a mixture of barytes and sphalerite having a zinc content of 16 per cent.

Cole County.—Very little ore was milled by the Black Jack Mining Co. in 1913. The zinc blende is mixed with barytes, and operations were suspended until experiments with the new Greenstreet separating process were completed. Galena ore mined by means of shallow shafts was shipped by Reuben Cole, of Russellville. A small quantity of blende having a zinc content of 53.8 per cent was shipped by the Dustless Coal Co.

Franklin County.—The Wrisberg Mining & Milling Co. completed a 100-ton concentrating plant and shipped some galena in 1913. The shaft is 100 feet in depth, and the ore body, apparently a crevice deposit, is reported to be developed for a distance of 600 feet both north and south from the shaft. A crosscut is reported to intersect another crevice deposit at a distance of 392 feet.

Washington County.—Several companies owning large tracts of land in Washington County, such as the Washington Land & Mining Co., the Southeast Missouri Lead Co., the Parole Mining & Mercantile Co. (successors to the Renault Lead Co.), work their property on a royalty basis. The ore which occurs at shallow depths and in association with barytes is mined in a small way and at odd times by the barytes miners. This ore is all hand picked and cleaned, there being no concentrating plants. There are numerous other shallow lead and barytes diggings scattered over Washington County which are worked by small operators and farmers, who sell their product to the country merchants and to ore buyers. Much of this ore was purchased by James Long, of Potosi, Higginbotham & Sons, of Fertile, and Buren Duckworth, of St. Claire.

Jefferson County.—The Valle Mining Co., with offices in Jefferson County, also operates on a subleasing or royalty system a large tract of land which lies partly in St. Francois County. The ores are galena and zinc carbonate and are found at depths ranging up to 225 feet, depending on the topography. The yield of both lead and zinc concentrates in 1913 was less than in 1912, but the average content of the zinc concentrates showed a slight increase. A new shaft which had reached a depth of 35 feet was being sunk on the Garatee tract. The estimated total depth of the shaft when completed will be 160 feet, and the land owners expect to mine a portion of the property instead of confining their operations to leasing.

On the tract there is a Scotch hearth lead furnace which has not been operated for several years and a kiln in which the zinc carbonate ore is calcined before shipment.

The following section of drill hole No. 1, about three-fourths of a mile nearly due south of Valle mines station, as interpreted by the Missouri Bureau of Geology and Mines, has been furnished by the Valle Mining Co.:

Section of drill hole No. 1, Valle mines, Jefferson County, Mo.

	Feet.
Surface	9
Potosi	227
Derby and Doe Run	94
Davis shale	170
Bonneterre	240
Total depth	740

Crawford County.—The Missouri Copper Mountain Mining Co. worked the Copper Hill mine near Sullivan for 90 days by means of a steam shovel in an open cut about 200 feet long. The production of iron and of oxidized ore carrying 8 per cent copper was not marketed.

Ste. Genevieve County.—The only copper ore from Missouri sold or treated in 1913 was that shipped by the Cornwall Copper Mining & Smelting Co., of Ste. Genevieve. The ore, which is oxidized, occurs in a flat sheet and was mined by means of several tunnels and sorted to a 10 per cent concentrate before shipment. In addition to the copper the ore contains a small amount of silver.

St. Francois County.—The St. Joseph Lead Co. (a description of whose mines, surface, and smelter equipment is given in the Central States report for 1912) reported the recovery of a larger quantity of galena concentrates in 1913, and the lead content of the concentrates was also slightly greater. The consolidation of the Doe Run Lead Co. with the St. Joseph Lead Co. did not become effective until after the end of 1913.

The Doe Run Lead Co. operated 4 shafts in the Flat River district, 1 shaft being 2 miles south of Doe Run. The addition to mill No. 3, which was the only one used in 1913, was put in operation in December. The capacity of the mill was increased from 2,500 to 4,000 tons daily.

This mill is one of the best equipped in the district. The building is of steel construction throughout. The mill machinery is operated by alternating current 440-volt motors, which receive their current from the central gas-electric power station at River-mines.

All shaft equipment, such as hoists, compressors, underground pumps, are motor driven.

Four 800-horsepower Snow twin tandem gas engines, direct connected, each with a 600-kilowatt generator, furnish power to all shafts and mill machinery. The gas-producer plant has four 800-horsepower Loomis-Pettibone producers and one 1,000-horsepower Westinghouse producer.

The underground haulage at shafts Nos. 1 and 4 is done by air locomotives. At all other shafts mule power is used. Shaft No. 9, which had been shut down for over a year, was placed in operation in December. No copper concentrates were produced in 1913.

The Desloge Consolidated Lead Co. in 1913 operated 3 shafts, 2 of which are each 300 feet and the other 500 feet in depth. Two of the shafts are near the town of Desloge, but No. 4 shaft is near

Leadwood. The concentrating plant is equipped with 2 Hancock jigs, 30 Wilfley tables, 10 Frue vanners, and appropriate rolls and Chile mills. The capacity is 1,700 tons per day of 24 hours. The smelter near the concentrating plant is equipped with 4 Flintshire-Tarnowitz reverberatory furnaces, only 2 of which have been operated in recent years, the "gray" slag being sold to other smelters.

The production of galena concentrates in 1913 was about as large as in 1912. It would have been considerably more had the mines not been idle in August on account of the strike.

The St. Louis Smelting & Refining Co. has its mines in the vicinity of the village of St. Francois, about 1 mile north of Flat River. Three shafts, ranging from 208 to 565 feet in depth, were in operation in 1913. The bottom of the ore was reached in shaft No. 6 at 540 feet and the Lamotte sandstone at 560 feet. The concentrating plant is modern, having a capacity of 2,200 tons per day of 24 hours, and is equipped with Hancock jigs, Overstrom classifiers and tables, Frue vanners, and slime and settling tanks. A central steam power plant drives air compressors and electric generators. The mill, hoists, and pumps are operated by electricity, as well as the underground haulage and the trams for handling the ore from the shafts to the mill. This company also operates a lead smelter and refinery at Collinsville, and the lead concentrates produced by the mines, and also those derived from crude ore purchased from the St. Francois Lead Co. were smelted at that plant. Most of the silver credited to Missouri in 1913 was recovered by this refinery.

On July 1, 1913, the St. Louis Smelting & Refining Co. took charge of the operating of the Mine La Motte property in Madison County.

The Federal Lead Co. operated three shafts during 1913, mining and milling approximately 1,200,000 tons of crude ore. The capacity of the mill and crushing plant was increased in 1912 to 4,600 tons and as now equipped it has 12 Hancock jigs, 72 tables, and 30 vanners arranged in 3 units of 3 sections each. There are also regrinding rolls, elevators, Esperanza-Federal drag classifiers, and, as a supplement to the slime treatment, a canvas plant of 48 by 14 foot canvas tables. During 1913 in addition to the regular lead shipments, a small tonnage of copper concentrates was recovered as a by-product, a roasting-magnetic separating plant being used for the purpose. This concentrate as shipped contained 960 ounces of silver and 20,643 pounds of copper. No silver was recovered from refining lead. About 4,500 horsepower is used in mining and milling, and is generated largely at a central steam power plant having Green chain stokers under the boilers and Curtis steam turbines for electrical power generation. Electric haulage is used underground. The mines and plants are located in the vicinity of Flat River, St. Francois County.

The St. Francois Lead Co., which purchased the Alma mine in 1912, operated 1 shaft which was 400 feet deep. The mine was developed and $50,000 was spent on equipment. No concentrating plant was erected, as the crude ore is shipped to the St. Louis Smelting & Refining Co.'s plant at St. Francois. The lead content of the crude ore which is sold on an assay basis is said to average about 7.5 per cent.

Madison County.—The Mine La Motte Lead & Smelting Co. and the St. Louis Smelting & Refining Co. operated 4 shafts during 1913 on a tract which was first mined in 1720. The shallow deposits which were

first worked were followed down to a depth of 100 to 125 feet, from which level the ore has been coming, which for 50 years has supplied the mill and smelter. The mill, which is practically new, has a capacity of 500 tons per day of 24 hours, and is equipped with Hancock and Harz jigs and tables. The attempt was made some years ago to smelt the copper and nickel-cobalt sulphides, which in certain parts of the mines occur plentifully with the lead and are separated in concentration. Of late years these ores have been avoided and attention in mining has been limited to the lead ores. The St. Louis Smelting & Refining Co. has been in control of the property since July, 1913.

The Federal Lead Co., during 1913, operated the old Phoenix and also the Fleming property under lease, mining and milling therefrom some 400 tons a day. The mill located at Phoenix No. 1 shaft was remodeled and enlarged in 1912 so as to handle this tonnage suitably. Coal is hauled in and concentrates are hauled out to the St. Louis Iron Mountain & Southern Railway by motor truck, a distance of 2¼ miles. The ore is low grade, and the ore bodies so far developed are not extensive. The property is located some 3 miles north of Fredericktown, in Madison County.

OKLAHOMA.

By J. P. Dunlop.

PRODUCTION.

The production of lead and zinc in Oklahoma in 1913 is shown in the following table:

Production of lead and zinc in Oklahoma in 1913, by districts, in short tons.

District.	Ore.						Metal content.[a]			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Carbonate and silicate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Ottawa County:										
Miami	7,710	$397,927	23,018	$725,163	.....	.....	6,150	$541,200	11,097	$1,242,864
Peoria	3	170	6	192	67	$1,340	2	176	25	2,800
Quapaw	97	5,000	1,097	41,037	.....	.....	76	6,688	542	60,704
State total:										
1913	7,810	403,097	24,103	766,392	67	1,340	6,228	548,064	11,664	1,306,368
1912	4,257	231,678	12,129	494,379	92	2,550	3,388	304,920	5,769	496,122

[a] In calculating the metal content of the ores for assays, allowance has been made for smelting losses in the case of zinc but not in the case of lead. In comparing the values of ore and metal, it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotation at New York.

The following table gives the crude lead and zinc ore output for the whole State of Oklahoma, but it was thought advisable to calculate the tenor of crude ore and concentrates as well as assay content and value of concentrates separately for the Miami and Quapaw districts,

inasmuch as the character of the ground operated in these districts differs so radically that general calculations for the State would be valueless:

Tenor of lead and zinc ore and concentrates produced in Oklahoma, 1912 and 1913.

	1912	1913
Total crude ore milled in Oklahoma.....short tons..	293,500	581,100
Miami district:		
Total concentrates in crude ore—		
Lead.....per cent..	2.1	1.5
Zinc.....do....	5.1	4.4
Metal content of crude ore—		
Lead.....do....	1.7	1.2
Zinc.....do....	2.6	2.4
Average lead content of galena concentrates.....do....	79.6	79.8
Average zinc content of sphalerite concentrates.....do....	51.8	53.6
Average value per ton—		
Galena concentrates.....	$54.42	$52.91
Sphalerite concentrates.....	$39.80	$31.50
Quapaw district:		
Total concentrates in crude ore—		
Lead.....per cent..	.....	0.2
Zinc.....do....	1.9	1.9
Metal content of crude ore—		
Lead.....do....	.....	0.13
Zinc.....do....	1.1	1.1
Average lead content of galena concentrates.....do....	79.5	78.4
Average zinc content of sphalerite concentrates.....do....	57.8	55.8
Average value per ton—		
Lead concentrates.....	$50.00	$51.55
Sphalerite concentrates.....	$48.36	$38.03

Oklahoma was the only one of the Central States which showed a larger output of both lead and zinc in 1913 than in 1912. The value of the silver, lead, and zinc produced at mines in Oklahoma in the year 1913, notwithstanding lower prices for all metals, was $1,855,217, compared with $1,101,042, in 1912. The metal content of lead concentrates increased from 3,388 tons, valued at $304,920, in 1912, to 6,228 tons, valued at $548,064, in 1913; and the recoverable spelter increased from 5,769 tons, valued at $796,122, to 11,664 tons, valued at $1,306,368.

The increased yield of lead and zinc in 1913 was entirely due to operations in the Miami field, as the mines in the Quapaw and Peoria districts reported a much smaller output and there were no shipments of sphalerite from the Arbuckle Mountain region in Murray County. The relatively small output of zinc silicate came entirely from the Peoria mines. Most of the mines in the Quapaw district were idle the greater portion of 1913, and the value of their product was about half that of 1912.

In 1913 the lead concentrates produced in the Oklahoma districts were of slightly higher grade than those shipped in 1912. The average selling price of lead concentrates was $1.55 a ton higher at Quapaw than in 1912. In the Quapaw district the tonnage of ore milled declined and the average per cent of concentrates contained in the crude ore increased slightly. The average metal content of the sphalerite concentrates from Miami ore increased from 51.8 per cent in 1912 to 53.6 per cent in 1913 and was only 2.2 per cent less than the average metal content of the sphalerite from the Quapaw district.

The lead concentrates from Oklahoma sold in 1913 were 3,553 tons more in quantity and $171,419 greater in value than in 1912. Miami

produced more lead than any district in the Joplin region, with the exception of Webb City-Carterville. The Oklahoma shipments of sphalerite in 1913 amounted to 24,103 tons, valued at $766,392. This was nearly double the production of 1912 and an increase in value of $272,013.

The shipments of zinc carbonate and silicate decreased from 92 tons in 1912 to 67 tons in 1913. The Miami district yielded over 95 per cent of the sphalerite concentrates and all but 100 tons of the galena concentrates sold in Oklahoma in 1913. In addition to the production of lead and zinc, 29 tons of silver ore were shipped from McClain County, which yielded 1,300 fine ounces of silver, valued at $785. The quantity of ore sold was small, but it was significant in that it was the first time that a production of silver from ore mined in Oklahoma has been reported to the United States Geological Survey.

The lead and zinc deposits of northeastern Oklahoma, so far as known, are confined to the limits of Ottawa County and form the southwestern extension of the Joplin region. There are three camps, Peoria, Quapaw, and Miami, where extensive mining has been done, and a fourth, the Sycamore Creek district, along the Seneca fault block from 2 to 3 miles southwest of Seneca, Mo., where considerable prospecting has been done and some ore mined.

Peoria is the oldest mining camp in the State, dating from 1891. Galena and blende were principally mined in the beginning, but in recent years the small output has been mostly of carbonate and silicate ores.

At Quapaw some shallow silicate and galena has been mined but the chief production is blende and galena ores from sheet ground at a depth varying from 80 to 150 feet. This sheet is known as a blanket breccia because the ore occurs in crevices and in the cement of the chert breccia and not between the chert sheets as in the typical sheet ground of the Webb City (Mo.) district. The ore is associated with pink spar and jasperoid but aside from the pink spar otherwise is similar to the sheet ground ores. The ratio of galena to blende is about 1 to 5.

At Miami the ores were first discovered 4 miles due north of town in a brecciated sandstone of Chester (late Mississippian) age. At the point first mined this sandstone lies at a depth of 90 feet from the surface and just below the Cherokee shale, of Pennsylvanian age. The ore body first discovered proved to be part of a long narrow run, which bears north-northwest and extends from the Cactus mine on the south to the Grey Top mine on the north, a distance of 1½ miles. Throughout this distance the ore body is in the sandstone breccia, with shale overlying, though at places in the run stopes have been taken up in the underlying chert breccia. The width of the run varies from 75 to 150 feet, and the height from 8 to 13 feet, ranging up to 25 feet where the lower stopes have been taken up. From the south end of this run the ore was found to increase in depth to the north until at the north shaft of the Church-Mabon mine about two-thirds of the distance to the north end of the run the depth to the bottom of the ore was found at 240 feet. From this point to the north end of the run the depth to the ore becomes less. At the Grey Top mine the top of the ore is found at 160 feet in chert, some distance below the sandstone. Four other runs parallel to the main run are

found to the southwest of it, but they are much shorter, the Midas-Golden Hen run with a length of something over half a mile being the longest. Practically throughout the south half of the long run deeper runs have been found below the upper ru[illegible] and are being worked in the Boone limestone.

A northeast run branches off from the long run about one-third of the distance from the north end and extends, as at present developed, about three-quarters of a mile. This run occurs along the highly inclined contact of the sandstone of Chester age and the Boone limestones and about midway of its course reaches from 150 feet to a depth of 285 feet. A deeper run is worked beneath the latter at a depth of 320 feet, but this is entirely in the Boone limestones.

A mile north of the end of this run is another northeast run nearly parallel but not exactly in line with the foregoing. A mile farther to the northeast several shafts have been opened in ore, but the openings are not large enough as yet to show the trend of the run. Two miles northwest of Miami there are shafts in ore, but here also the openings are not large enough to determine the trend of the ore body.

The ores are galena and sphalerite in the proportion of about one of the former to three of the latter, no oxidized ores having yet been found.

The sandstone in the older and shallower mines was impregnated with a heavy oil, which, evaporating to asphalt, caused much trouble in saving the concentrates, by balling up the ores on the jig beds and tending to float off the finer particles. As mining developments in the upper level worked away from the territory first opened in the southern part of the field and as the deeper level was opened in the original district, it was found that the oil became much less plentiful. It now seldom occurs in quantity sufficient to make any trouble in milling or to affect the grade of the concentrates.

DISTRICT REVIEW.

Peoria district.—There was very little mining at Peoria, the site of the first lead and zinc mining in Oklahoma, in 1913, and the output of zinc carbonate was 23 tons less than in 1912. The ore was all obtained from shallow shafts on the Ray, Scott, and Mountjoy lands. The district is handicapped by lack of rail transportation.

Quapaw district.—Very few of the mines in this district were operated and others were only worked for a portion of the year. In consequence of this condition and the lower average price paid for sphalerite the value of the lead and zinc concentrates shipped declined from $78,504 in 1912 to $46,037 in 1913. The quantity of zinc concentrates shipped in 1913 was more than 500 tons less than in 1912, but there was an increase of galena concentrates amounting to 96 tons. Lessees of the Iowa-Oklahoma Mining Co. produced about two-thirds of the sphalerite and the Falulah Mining Co. (Mission) nearly all the galena concentrates.

The lessees on the land of the Iowa & Oklahoma Mining Co. who produced concentrates were C. E. Miller, the Good Luck Mining Co., the Newlands Mining Co., the Katy Lee Mining Co., and Thos. Hackwood (White Eagle mine). Four shafts were in operation, and ore was extracted from levels at depths ranging from 62 to 90 feet.

The White Eagle mine, which has a milling plant capable of treating 250 tons of ore daily, was the largest producer in 1913. The new lessee pumped the water from the mine, and the mill was started early in 1913, but was closed down when the price of sphalerite declined in the spring.

The Newlands Mining Co. sunk a new shaft 142 feet and made many surface improvements. The 200-ton concentrating plant was operated, producing both galena and sphalerite concentrates, but the heavy pumping costs made mining unprofitable at the low prices paid for sphalerite.

C. E. Miller made a good production from ore taken out by means of a 70-foot shaft and treated on hand jigs.

The Falulah mine (old Mission) was leased to M. G. Estabrook. The mine was unwatered, and the mill, which is of 400 tons capacity, operated until June, 1913. The double compartment shaft at the mine is 80 feet deep. A small output of sphalerite was recovered on the Paul Ewart land by John Duvall, who mined dirt on the 120-foot level. A 70-ton concentrating plant was erected in 1913.

Miami district.—The mines of the Miami district in 1913 shipped 7,710 short tons of galena concentrates, valued at $397,927, and 23,018 short tons of sphalerite concentrates, valued at $725,163. This shows an increase of 3,454 tons of galena concentrates and of 12,760 tons of sphalerite concentrates when compared with the output of 1912. Although the average selling price of both lead and zinc concentrates was much lower than in 1912, the total value of the concentrates shipped from Miami in 1913 was $485,487 greater than in 1912.

The quantity of crude ore mined and milled increased from approximately 200,000 tons in 1912 to 525,000 tons in 1913. The per cent of concentrates recovered from crude ore milled was larger than in any other district in the Joplin region, though with increased operations the "dirt" treated showed a natural decline in percentage of concentrates recovered. The average metal content of all of the blende concentrates sold increased from 51.8 per cent in 1912 to 53.6 per cent in 1913. The separate assays reported showed the zinc content to range from 43.6 to 61.2 per cent, and most of the blende assayed from 53 to 57 per cent. The average selling price of galena concentrates declined from $54.42 in 1912 to $52.91 in 1913, and that of blende concentrates from $39.80 in 1912 to $31.50 in 1913. The recovery of galena concentrates from all the mines averaged about 1 ton to 3 tons of sphalerite, which is much higher than in any other district in the Joplin region. The proportion of galena concentrates recovered from the dirt mined showed wide variations, ranging in different mines from 1 ton of galena to 15 tons sphalerite, as high as 1.4 tons of galena to 1 ton of sphalerite. The mines lying to the north of the original Miami camp reported 4,893 tons of galena and 9,119 tons of sphalerite, while those south of the new mining area reported the production of only 2,817 tons of galena to 13,899 tons of sphalerite.

Prior to 1912 most of the ore was derived from the upper runs of ore, which varied from 90 to 130 feet in depth. By the end of the year 1911 much of the ore between these depths had been exhausted in many of the mines and though several mines operated on the upper

run of ore very successfully, an increased proportion of the ore treated in 1913 was taken from a lower run of ore below 200 feet. The draining of the ground by the large centrifugal pump placed in a shaft on the Miami Zinc & Lead Co.'s lease on the Emma Gordon land gradually lowered the water level to 320 feet by the end of 1913, and ore was hoisted from levels as low as 250 feet in the southern mines of the camp. The ore hoisted from the mines in the northeastern and northwestern parts of the camp came from the average depths of 240 feet to 260 feet. The blende concentrates from the newly opened lower run at the south are of much better grade than those obtained from the upper ore run, which averaged about 50 per cent zinc.

The quantity of galena concentrates recovered at depths of 200 to 320 feet in the northerly mines was much greater than that obtained from working the lower run of ore in the mines in the south end.

Drilling operations were steadily carried on, not only ahead of the drifts in the mines opened, but also in an extensive area reaching east to the vicinity of Tar Creek, north to the Kansas-Oklahoma State line, and southwest across the Neosho River. The percentage of prospect holes showing ore was larger than of those which were reported blank. The drilling was done by many land owners and lessees, including the Commerce Mining & Royalty Co. (which had 7 rigs in operation), Church & Mabon, Picher Lead Co., Barnes & McConnell, T. T. Lennan, and Longacre & Chapman. Only a very small output of concentrates was made in 1913 from mines north of the Lennan Zinc & Lead Co. or south of the old Hattenville group of mines, but a number of shafts were sunk and several mills built, which are now being operated. Four mines on Commerce leases, from three of which the concentrating plants had been removed, were reopened and all made good outputs. One of these, the Mispah, was the largest producer of sphalerite in the district. The successful operation of these old leases indicates that the former lessees had not been sufficiently thorough in prospecting. The concentrating plants in the camp have also been improved, especially with regard to the handling of sand and sludge.

The mines on Emma Gordon leases produced over 47 per cent of the galena concentrates, and mines on Commerce leases yielded over 62 per cent of the sphalerite concentrates. The mines on Emma Gordon land which shipped concentrates in 1913 were the Standifer Mining Co., High Five Mining Co., Carson Mining Co. (Oklahoma and Carson-Dodson mines), Thirty Acre Mining Co., Prairie Mining Co., and Lennan Zinc & Lead Co. At the original Emma Gordon mine Standifer Bros. mined ore at the 244-foot, 200-foot, and 163-foot levels by means of 2 shafts. The Emma Gordon mill is of 200 tons capacity and the High Five mill, which ran on tailings from the Emma Gordon mine, is of 125 tons capacity.

North of the Emma Gordon and connected by drifts, the Carson Mining Co. had 6 shafts in operation working ground at levels between 200 and 260 feet. Two mills having a total capacity of 300 tons and driven by power supplied by Bessemer gas engines, were used to concentrate the ore. The 200-ton mill was erected early in 1913. The Thirty Acre Mining Co., directly north of the Carson Mining Co., has a 200-ton concentrating plant, which was operated steadily in 1913. The lease of the Prairie Mining Co., directly east of the Carson Mining Co., mined ore by means of a 240-foot shaft; the ore was milled on a

200-ton concentrating plant erected in 1913. The dirt milled ran over 4 per cent in concentrates, of which nearly half was galena. North of the Prairie on Emma Gordon land similar ore was mined at the 260-foot and 280-foot levels and milled by the Miami Zinc & Lead Co. at a 250-ton concentrating plant operated by means of a gas engine. The large pump which has so successfully lowered the water level of the entire camp is situated on this lease.

Northeast across the road, on Commerce Mining & Royalty land, is situated the Lennan Zinc & Lead Co.'s mine and 200-ton mill. Two shafts were in operation at this mine, and ore was hoisted from the 260-foot, 280-foot, and 320-foot levels. The ore from the 320-foot level, which was first mined in November, 1913, is of much higher grade than that from the upper levels. Some ore from the new shaft on the Pius Quapaw land lying northeast of the Lennan, and on which M. R. Tidwell and the Commerce Mining & Royalty Co. hold first lease, was treated at the Lennan mill. The sphalerite concentrates recovered were low grade, but the galena concentrates, which predominated, were of high grade. Farther northeast, near Tar Creek, the McConnell Lead & Zinc Co. sank two shafts, one of which was down to the ore body in 1913. A large mill of 350 tons capacity was erected, but no concentrates were sold in 1913. The fuel used at this mill will be changed from coal to natural gas.

The Blue Bird mine, on the Cooper & Goodwin land, in sec. 25, T. 29, R. 22, was developed by Church & Mabon, and the erection of a 150-ton concentrating plant was commenced. The Grey Top Mining Co., on the Lennan land, operated a mine and mill which marked the northwest limit of the producing area in the district. A shaft was sunk and ore was hoisted from the 260-foot level, and a 250-ton concentrating plant, driven by a gas engine, was built in 1913. The dirt mined averaged 1 ton of galena concentrates to 6 tons of sphalerite. The productive mines on leases in the immediate vicinity of Hattenville, on land of the Commerce Mining & Royalty Co., were the Cactus, New State, Mispah, Queen City-Joplin, Frosty Morning, Eureka, Turkey Fat, Jeanette, King Jack, Never Sweat, Midas, Old Chief, and Miami Amalgamated (Sullivan). The Mispah, in the southeast end of the Hattenville camp, was the largest producer. The property is equipped with a 250-ton mill, and ore was mined from the 180-foot level by means of two shafts. The Cactus, on the adjoining lease to the south, also has two shafts and a 250-ton mill. Ore from the 200-foot level was mined. The King Jack lease produced a large quantity of sphalerite, but very little galena. One mill of 150 tons capacity was run on ore from the 240-foot level, and a smaller mill of 80 tons capacity, owned by Zillar Bros., was run on old tailings. The Kansas Mining Co. raised ore from the 217-foot level of the New State mine, which adjoins the King Jack property. Standifer Bros. made a good production of high-grade concentrates from ore mined at the 244-foot level of the Old Chief mine which is equipped with a 150-ton mill. The Miami Amalgamated Lead & Zinc Co. (Sullivan lease) sold a large portion of the sphalerite produced in the district that assayed above 60 per cent zinc. This concentrate was derived from ore mined at the 235-foot level by means of two shafts, and was treated at a 200-ton concentrating plant. The ore body is said to extend 15 feet below the level mined in 1913. The Turkey Fat Min-

ing Co. made its usual large production. The ore mined in 1913 came from the 220-foot level. The Midas, Lost Trail (Frosty Morning), and Queen City-Joplin all made good outputs. Each property is equipped with a mill of 150 tons capacity. The depth of mining was 190 feet at the Midas, 160 feet at the Lost Trail, and 205 feet at the Queen City-Joplin. Shipments of concentrates were made from the Eureka, Jeanette, and Never Sweat mines. Southwest of Hattenville a 90-foot shaft was sunk by W. B. Neel on the McCuddy & Co.'s land. The ore hoisted was treated by means of two hand jigs.

About a mile and a half northwest of the city of Miami a lease on Miami Royalty land was drilled by McConnell & Barnes. The drill cuttings were so good that two shafts were sunk and a 200-ton concentrating plant was under construction in the latter part of 1913. This is the most southern and western plant in the Miami district.

SOUTHERN AND CENTRAL OKLAHOMA.

Murray County.—No production of zinc concentrates was reported from the Arbuckle Mountain district in 1913. A description of the region, ore occurrence, and development of the mines was given in this report for 1912.

McClain County.—The production of silver in Oklahoma in 1913 amounted to 1,300 fine ounces, valued at $785. Although the quantity was small, it was notable for the reason that it was derived from ore in which silver values predominated, and was the first shipment of ore of that character from Oklahoma ever reported to the Survey. The ore shipped in 1913 was mined by C. T. Criswell, of Byars, in McClain County, from land owned by him, located about 5 miles west of Byars, on the SW. ¼ SE. ¼ sec. 33, T. 5, R. 3 E., about 100 yards north of the boundary line between Garvin and McClain counties. The ore deposits lie on the side of a canyon running north and south, and there was evidence that prospecting had taken place before the present owner of the property purchased it. The ore shipped in 1913, amounting to 29 tons (also 70 tons not sold in 1913), was obtained from shallow open cuts and hand-sorted before shipment. The ore, which is a light-gray decomposed sandstone, containing silver chloride and a small quantity of copper, has averaged about 37 ounces of silver a ton. The extent of the ore deposit has not been determined; but if further development warrants the expenditure, a suitable plant will be built to treat the ore.

WISCONSIN.

By J. P. Dundop.

PRODUCTION.

The production of lead and zinc in Wisconsin in 1913 is shown in the following table:

Production of lead and zinc in Wisconsin in 1913, by districts, in short tons.[a]

District.	Ore.						Metal content.			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Carbonate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Benton	823	$39,997	30,800	$680,815	19	$181	603	353,004	9,946	$1,113,952
Cuba City	189	9,403	4,175	84,404	.....	.....	117	10,296	1,163	130,256
Dodgeville	33	1,662	250	5,772	.....	.....	26	2,288	77	8,624
Hazel Green	276	12,636	18,499	377,226	.....	.....	195	17,160	5,696	637,952
Highland	51	2,790	.....	.....	2,088	16,957	40	3,520	374	41,888
Linden	413	21,038	10,715	160,303	.....	.....	311	27,368	2,655	297,360
Livingston	70	3,265	11,940	232,627	.....	.....	49	4,312	3,081	345,072
Mifflin	44	2,291	4,401	105,672	.....	.....	34	2,992	1,443	161,616
Mineral Point	[b]37	1,700	278	3,728	1,016	13,631	26	2,288	302	33,824
Montfort	90	4,050	1,300	30,000	.....	.....	66	5,803	442	49,504
Platteville	138	6,724	11,774	330,406	.....	.....	101	8,888	4,382	490,784
Shullsburg	368	19,021	1,347	42,208	.....	.....	298	26,224	549	61,488
State total	2,532	125,197	95,540	2,053,341	3,123	30,769	1,866	164,208	30,110	3,372,320
1912	3,373	180,661	102,617	2,908,892	4,370	72,800	2,581	232,290	33,050	4,560,900
1911	4,359	229,465	93,963	1,929,123	5,035	74,143	3,353	301,770	29,720	3,388,080
1910	5,008	286,493	89,232	1,750,574	5,269	69,588	4,413	388,344	25,927	2,800,116
1909	4,059	254,514	65,421	1,505,752	5,130	63,603	3,694	317,684	23,152	2,500,416

[a] In calculating the metal content of the ores from assays allowance has been made for smelting and concentration losses in the case of zinc, but not in case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer and that the value of the metal is calculated from the average daily quotations at New York and St. Louis.

[b] Includes a few tons of lead carbonate.

Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1912 and 1913.

	1912	1913
Total crude ore.....short tons..	1,363,636	1,406,000
Total concentrates in crude ore:		
Lead.....per cent..	0.25	0.18
Zinc.....do....	7.6	7.04
Metal content in crude ore:		
Lead.....do....	.2	.13
Zinc.....do....	2.9	2.6
Average lead content of galena concentrates.....do....	76.5	74.8
Average zinc content of sphalerite concentrates.....do....	38.4	38.0
Average zinc content of zinc carbonate concentrates.....do....	29.6	23.0
Average value per ton:		
Galena concentrates	$53.57	$49.16
Sphalerite concentrates	$28.34	$21.53
Zinc carbonate concentrates	$16.66	$9.85

The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette counties and comprise the most important part of the ore deposits of the upper Mississippi Valley region. The ore deposits

occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age. The ores are galena, sphalerite or zinc blende and smithsonite or zinc carbonate, the latter locally known as "dry bone." As a lead region the district has been known from the earliest settlement days. In time the building of smelters near by made a market for the zinc ores. The first zinc ore to be mined was the carbonate found in association with lead in the shallow working above ground-water level. When all the main deposits were worked out down to water level there was a lull in mining in the region. Though the carbonate was known to give place to zinc blende and the lead to continue on below water, it was not deemed profitable to mine when continued pumping was necessary. About 8 or 10 years ago the higher price of zinc led to the opening of some of the deposits below water level, since which time zinc mining has increased until Wisconsin in 1911 and 1912 stood third and in 1913 fourth in rank among zinc-producing States. The ore bodies are found in perpendicular, horizontal, or inclined cavities known as "openings" or "crevices," "flats," and "pitches." These openings sometimes extend for a considerable distance in a straight line called a "range," and may be operated at different places by different companies. When a range is once established it becomes an important guide in prospecting.

The galena of the district is nonargentiferous, and so far as known the zinc ores are free from cadmium. In some of the mines marcasite is so plentiful that the zinc blende concentrates are reduced to a very low grade. Owing to their nearness in specific gravity, marcasite and blende are very difficult to separate cleanly by hydraulic methods. Both electrostatic and electromagnetic separation processes have been used.

A small number of the concentrating plants in the district are equipped with roasters and magnetic separators. Some mining companies having such equipment did not operate it, and the companies constructing milling plants in 1913 did not report the erection of roasters. It is believed by many mine owners that it is more economical to sell the green concentrates than to invest in a roasting plant, entailing the employment of extra shifts of men during the entire day of 24 hours. The Linden Zinc Co. operate a roaster and magnetic separator at Linden to treat ores from the Optimo No. 1 and No. 2 mines owned by affiliated interests. The Mineral Point Zinc Co. operates a roaster and magnetic separator at Mineral Point, Wis., and green concentrates are treated by the Wisconsin Separating Co. at Benton, the National Zinc Separating Co. at Hazel Green, the Empire roaster at Platteville, and the Campbell Magnetic Separating Co. at Cuba City. The last-named plant, which has been purchased by the Wisconsin Zinc Co., and that of the Linden Zinc Co. use a patented process, which requires the ore to be only slightly roasted and which recovers the marcasite and pyrite in shape for sale to acid manufacturers.

At the other plants the concentrates, after being dried, are roasted, the customary form of roaster being a long, slowly revolving cylinder lined with fire brick. The roasting is carried far enough to render the marcasite magnetic, but not to drive off all the sulphur, after which the concentrates are passed under a magnetic separator, which removes the iron.

The multiplication of individual and custom roasters, by raising the low-grade ore to high grade, has a tendency to reduce relatively the quantity of zinc concentrates, though, of course, the metal content and the value will be less affected; hence these last must serve as the basis of comparison for different years. It is rather difficult to estimate the exact quantity of green ore treated at separating plants, as the Mineral Point Zinc Co. operates an oxide plant and also a separating plant at Mineral Point, and a portion of the green ore purchased is used at the oxide works without being treated at the separating works. Probably 70 per cent of the sphalerite concentrates shipped by mines in Wisconsin in 1913 went to separating companies. The quantity of roasted concentrates sold by mining companies owning their own separating plants was very small when compared with the aggregate shipments.

The average zinc content of the sphalerite concentrates sold in 1910 was 34.8 per cent and the average price per ton was $19.62; the corresponding content and price for 1911 were 34.6 per cent and $20.53; for 1912, 38.4 per cent and $28.34; and for 1913, 38 per cent and $21.53.

Milling practice is much as in the Joplin region, except that in Wisconsin everything is on a smaller scale. Mills of 100 tons or more, with rougher, cleaner, sand jigs, and concentrating tables, have generally been built in the last few years.

The percentage of concentrates recovered from crude ore is much higher than in the Joplin region, but the zinc concentrates average 20 per cent less in zinc content. On account of these conditions, at many mines no close recovery is made and the tailings, though containing large quantities of zinc, are seldom reworked.

The mills erected in 1913, with their reported capacity (per 10-hour shift) and location, were the following: Frontier Mining Co. (Bull Moose mine) 100 tons, at Benton; Sans Souci Mining Co., 50 tons, at Benton; Vinegar Hill Zinc Co. (Martin mine) 100 tons, at Benton; Vinegar Hill Zinc Co. (Mausbruk mine) 100 tons, at Cuba City; Grunow Mining Co., 75 tons, at Mifflin; Lawrence Mining Co., 100 tons, at Hazel Green.

The crude ore yields from 5 to more than 20 per cent of concentrates. The mining methods are largely determined by the mode of occurrence of the ores, but otherwise are similar to those in vogue in working the pockety ores at Joplin.

The zinc carbonate ore, which is mined principally in the Highland and Mineral Point districts, is purchased by the Mineral Point Zinc Co. and made into zinc oxide in the plant at Mineral Point, Wis. A considerable quantity of the low-grade zinc blende concentrate is used in the same way.

The metal content of the sphalerite concentrates sold by the mines varied in 1913 from 18.8 per cent to 58 per cent. The larger portion of the concentrates sold ranged between 30 and 45 per cent. The average zinc content has increased considerably during the last two years. This increase was not wholly due to the roasting plants operated by the mine owners, but was partly due to the shipment of a very large output of high-grade green concentrates by the Field Mining & Milling Co., at Benton.

The value of the mine output of lead and zinc in Wisconsin for the year 1913 was $3,536,528, against $4,793,190 in 1912, so that the decrease was $1,256,662.

The lead concentrates sold declined from 3,373 tons, valued at $180,661, in 1912 to 2,532 tons, valued at $125,197, in 1913. The sphalerite concentrates sold decreased from 102,617 tons, valued at $2,908,892, to 95,540 tons, valued at $2,053,341, and the zinc carbonate concentrates from 4,370 tons, valued at $72,800, to 3,123 tons, valued at $30,769.

The metal content of the lead concentrates in 1913 was 715 tons less than in 1912. The recoverable zinc content of the sphalerite and zinc carbonate concentrates decreased 2,940 tons from that of 1912, and the value was $1,188,580 less.

The Benton district was much the largest producer of both lead and zinc concentrates, though the yield of galena declined 256 tons and that of sphalerite 4,217 tons, compared with 1912. Hazel Green was the next largest produces of sphalerite, with shipments of 18,499 tons, or about 1,100 tons less than in 1912. The only districts in Wisconsin which showed materially increased shipments of lead and zinc concentrates were Linden and Livingston. A comparison of the tonnage of ore treated in 1913 with that of 1912 indicates that the large companies probably mined a lower-grade ore in 1913, and that part of the concentrates produced was held for higher prices.

The average tenor of the sphalerite ore was approximately the same in 1913 as in 1912, but the average price paid for the concentrates was nearly $7 a ton less. The average zinc content of the zinc carbonate ore declined from 29.6 per cent in 1912 to 23 per cent in 1913, and the average value of this class of concentrates was about $6.80 a ton less in 1913 than in 1912. This decline in the tenor of zinc carbonate concentrates was due mainly to the shipment of a large quantity of sludge from the Franklin mine and other Highland mines, after they are acquired by the Mineral Point Zinc Co. If this low-grade sludge had been eliminated from the shipments of zinc carbonate the tenor of such concentrates shipped in 1913 would have been only slightly less than the concentrates sold in 1912.

Although drilling was active in many of the camps and resulted in a great amount of development, the area of proved mining territory was not expanded materially. The larger mining interests, including the Mineral Point Zinc Co., Wisconsin Zinc Co., and Vinegar Hill Zinc Co., continued to add to their holdings by lease or purchase. In addition the Cleveland Mining Co., the Frontier Mining Co., the Field Mining & Milling Co., and the Optimo Mining Co. increased the scope of their operations by acquiring new fees or leases. The prominence of the above-named seven companies is adequately shown by the fact that their combined output was approximately 44 per cent of all the lead concentrates and 77 per cent of all the zinc concentrates shipped from Wisconsin mines in 1913. In view of the investments made by them in new lands and leases there is reason to assume that in 1914 and succeeding years an even larger proportion of the Wisconsin lead and zinc output will be made by them.

The new development work and transfers of property are set forth under the district reviews.

REVIEW BY DISTRICTS.

Benton district.—This district which had much the largest output in the State produced about 32 per cent of the galena concentrates and 40 per cent of the sphalerite concentrates sold in Wisconsin in 1913. The quantity of galena concentrates was about 250 tons less and that of zinc concentrates about 4,200 tons less in 1913 than in 1912. The total value of all concentrates sold in 1913 was $720,993, compared with $1,127,122 in 1912. In addition to the shipments of lead and zinc concentrates about 20,000 tons of marcasite were shipped. More new properties were developed and equipped than in other districts.

The Field Mining Co. had the largest output of good green sphalerite concentrates and galena concentrates in Wisconsin in 1913. The sphalerite sold in 1913 had an average zinc content of 49 per cent. This mine is situated on the Crawhall land. The ore is hoisted from the depths of 160 to 210 feet by means of 2 shafts, and treated in a 200-ton concentrating plant. The company prospected with drills 80 acres of that part of the Thompson land lying east of the Crawhall lease. The drilling showed a continuation of the ore body. A shaft will be sunk and a 250-ton mill will be erected on the lease.

The next largest output of sphalerite in the district was made by the Wisconsin Zinc Co. from the Winskill mine. The 2 shafts are 125 feet and 115 feet deep, respectively, and the property is equipped with a 100-ton mill, driven by electric power.

During the fall of 1913 the Champion Mining Co.'s property in the NE. ¼ NE. ¼ sec. 27, T. 1 N., R. 1 E., was drilled by the Wisconsin Zinc Co. It is reported that 24 out of the 25 holes showed ore that could be profitably mined. A shaft will be sunk and suitable mill equipment erected.

The Fox mine, owned by the Mineral Point Zinc Co., was a large shipper of sphalerite and galena, and the mine workings on the Weigle land were further developed. The shaft at the mine is 140 feet deep, and the electrically operated concentrating plant has a capacity of 100 tons.

The Vinegar Hill Zinc Co. operated the Wilkinson, Rowley, and Martin mines and made a good output of galena and sphalerite. The Rowley mine, which was equipped with a 75-ton plant, was operated only until April, 1913, when the plant was dismantled and the lease surrendered. The Wilkinson mine has a shaft down 90 feet and an electrically-driven concentrating plant of 100 tons capacity. In addition to the output of galena and blende concentrates a large quantity of marcasite, averaging 45 per cent of sulphur, was shipped from the Wilkinson mine. The blende concentrates derived from the ore from the Wilkinson mine have a much lower zinc content than those from the ore of the Rowley mine or the Martin mine.

The Martin mine at Strowbridge, 3 miles south of Benton, was developed in 1913. A 160-foot shaft was sunk and a 100-ton concentrating plant was erected and operated late in the year.

The Lucky Twelve mine on the Murphy land sold both green and roasted blende concentrates. The shaft at the mine is 118 feet deep and the mill has a capacity of 125 tons. The mine is one of the few equipped with a roasting plant, and about half of the blende concentrates sold averaged 56 per cent zinc content. The Frontier Mining

Co. was the third largest producer of sphalerite in the district. The output was derived from the mine on the Robinson land, which is equipped with a 126-foot shaft and a 100-ton mill. The company prospected and sunk shafts on the Hird land and the Grotkin land. At the Hird mine the shaft was down 98 feet, and sinking was still in progress. The shaft at the Bull Moose mine on the Grotkin land is 164 feet deep, and the concentrating plant erected in 1913 has a capacity of 125 tons. A heavy flow of water, approximately 2,600 gallons a minute, was encountered in sinking the shaft. Lawyer & Temple operated a 100-ton mill situated on a small stream, in which ore tailings and sludge from the Frontier and other mines had been accumulating for years.

The Ewing Mining Co. operated the Etna mine by means of an 82-foot shaft and recovered some concentrates from ore treated at the 100-ton mill, which was run for only a short period.

The Schreier Steffen Co., after producing some blende at the Sally Waters mine, surrendered the lease. The Lafayette Mines Co. also closed down after a brief run.

The Kearns mine, leased by the Grand View Mines Co. and equipped with a crusher and hand jigs, made a good output of sphalerite concentrates but only a small part of the production was shipped in 1913. A small output of galena was shipped by the Piquett Mining Co. on the Duval land.

Longhenry Bros. have 4 shafts on the Spenceley land. These shafts were 27, 44, 140, and 111 feet deep. Some ore was extracted during development, but none was treated. It is reported that good ore has been found on the lower levels and that a concentrating plant will be erected in 1914.

The 50-ton mill of the Eureka Mining Co. was purchased by the Sans Souci Mining Co. and was moved to a mine developed on the Lafayette land. The plant was not ready for operation until the beginning of 1914. The Acker Mining Co. did nothing but prospecting in 1913.

Cuba City-Elmo district.—The production of lead concentrates in 1913 this district was 554 tons less than in 1912 and that of sphalerite was 507 tons less than in 1912. Most of the 1913 output came from the newly developed Mausbruk mine or from old mines operated by new companies. Several mines formerly very productive were closed down throughout the year.

The Jarrett mine on the Banfield land, under lease to the M. & D. Mining Co., produced considerable lead and zinc concentrates. A 100-ton mill was operated until the ore body was cut out and operations were suspended.

The Baxter mine and mill, operated by the Burr Mining Co., made the second largest output of concentrates in the district. Ore was milled until April and after that time old tailings were remilled until the plant was closed down in December. The 100-ton mill on the Raisbeck lease was only operated by the Vinegar Hill Zinc Co. until February, 1913, when the mill was dismantled and the lease surrendered. The company has developed a new mine on the Mausbruk land, sunk a shaft, and erected a 100-ton concentrating plant. This mine was the largest producer in the district in 1913. The capacity of the National Zinc Separating Works, belonging to the company, was doubled, and the plant treated over 10,000 tons of green ore pro-

duced by mines operated by the company. The Universal Mining Co. only operated the Lawrence mine and 150-ton mill for about two months and the Board of Trade mine was idle all the year, though a test run on old tailings was made at the 100-ton mill.

R. A. Fox operated a lease on the Vandeventer, which is equipped with a 50-ton concentrating plant and a roasting and separating plant of 20 tons capacity. Only green concentrates were shipped.

The Barnett Development Co. operated the Roosevelt lease on the Badger land and conducted an active search for new ore bodies. Three shafts were worked and the 100-ton mill was run in December on ore hoisted from levels between 50 and 90 feet.

The Long Range Mining Co. took over the old Best and Midway mines with the 125-ton mill, and a small quantity of concentrates were sold in 1913. The Fever River property was sold to Utt & Thorne, who also purchased the Wicklow equipment, but no concentrates were produced in 1913. The Campbell separating plant was idle all the year and has since been purchased by the Wisconsin Zinc Co. The Beloit Elmo mine, which had been idle for two years, was taken over by the Midland Mining Co. and placed on a productive basis. No shipments of concentrates were made in 1913.

Dodgeville district.—The production of lead concentrates decreased in this district from 105 tons in 1912 to 33 tons in 1913, and the output of sphalerite decreased from 608 tons in 1912 to 250 tons in 1913. The Lucky Five Mining Co., on the Davis land, was the largest producer of concentrates. The shaft at this mine is 100 feet deep, and the concentrator has a capacity of 50 tons. The Treweek land, leased by the Lucky Five, was drilled, a shaft was sunk, and other development work was done. Harney, Bengeley & Davey shipped galena and sphalerite concentrates from a mine on the Hughes land. Some prospecting was done at the Henry T. Roberts mine, but no shipments were made.

Hazel Green district.—Although there were only five producing properties in this district in 1913, the production of lead concentrates amounted to 276 tons, and of sphalerite concentrates to 18,499 tons. The district ranked second in point of production in Wisconsin in both 1912 and 1913, although the quantity of both lead and zinc concentrates shipped in 1913 was slightly less than in 1912.

The Kennedy mine of the Mineral Point Zinc Co. is the largest in the district, and was also one of the largest producers of sphalerite concentrates in Wisconsin in 1913. The ore mined was taken from levels between 100 and 175 feet and concentrated at a 200-ton plant.

The Cleveland Mining Co. shipped about the same quantity of sphalerite from the Cleveland-Scrabble mine as was shipped from the Kennedy, and the zinc content of the concentrates was considerably higher. The ore was mined through several 140-foot shafts and was milled at a plant having a capacity of about 150 tons per 10-hour shift. Considerable exploration work was done at the Cleveland-Scrabble mine and also some prospecting on the Byrne land. The Lawrence mine was also developed by the Cleveland Mining Co. A 7 by 10 shaft was sunk 275 feet and a 100-ton mill was under construction.

The Federal mine and 100-ton mill was transferred in February, 1913, to the Wisconsin Zinc Co. The property was operated steadily and yielded a larger output of concentrates than in 1912. Some

galena taken from shallow workings was shipped by Nolte Bros. and Thos. Pedelty. The mills and Badger mines remained idle all year.

Highland district.—There were many changes in the owners of mining properties and a considerable amount of prospecting and development done in the district, but the production of all classes of concentrates declined. The 1913 output of galena declined 109 tons, that of zinc carbonate 2,020 tons, and that of sphalerite 157 tons. The Mineral Point Zinc Co. purchased the entire interests of the Highland Mining Co., Franklin Mining Co., and Minter Mining Co., and all will be operated as the Highland mine. The plant at the Highland was remodeled and other surface equipment was constructed. The 200-ton concentrating plant was only run during the last three months of 1913. In addition to the concentrates from ore milled, a large quantity of low-grade sludge was shipped. The Red Jacket mine was also purchased, but both it and the Minter remained idle.

The Burrichter mine was worked by Delaney & Miller, who sold some galena and zinc carbonate. Lampe & Steppler obtained some ore by means of a 40-feet shaft, but made no sales. The Kennedy & Egan mine on the Muldoon land produced some sphalerite concentrates derived from ore mined at the 67-foot level but made no shipments

Galena or zinc carbonate concentrates were shipped by the following: John Schaack Mining Co., Henry Hying, H. Topp & Co., Atlas Mining Co., Kruel & Richter, Cheney & Co., and Mulderney & Gunn (St. Anthony's mine), Whelan Bros., and Waters & Fecht.

Linden district.—In 1913 the production of galena concentrates increased 250 tons and that of sphalerite 3,051 tons, when compared with the production in 1912. The increase was due mainly to the large output from Optimo mines Nos. 1 and 2. The ore hoisted from Optimo No. 1 was hoisted through one shaft from the 110-foot level and was treated at a 75-ton mill. Optimo No. 2 on the Smith land, first operated in May, 1913, was the largest producer in the Linden district. The mill at this mine has a capacity of 125 tons and is operated by electric power. The Linden Zinc Co. completed the roasting and separating plant which was under construction late in 1912. The Campbell patented process is used at this plant which treated green concentrates from the Optimo mines. In addition to shipping sphalerite having a zinc content of 59.5 per cent, a quantity of marcasite was sold to acid manufacturers.

Ross Bros. sold the largest quantity of galena concentrates and the second largest quantity of sphalerite concentrates in 1913. The shaft at this mine is 110 feet deep and the concentrating plant has a capacity of 60 tons. The Hinkle Mining Co., on the Heathcock land, was another large producer of both galena and sphalerite. One 80-foot shaft was used to hoist ore for the 50-ton mill.

The Glanville Mining Co.'s lease on the W. M. Smith land was a large producer of sphalerite but shipped no galena. Four shafts and a 50-ton mill were operated.

The old Platteville-Linden mine and 100-ton mill on the Weigle land, which has been idle some years, was taken over by the Saxe-Pollard Mining Co. Ore was mined from the 120-foot level, yielding a large output of both galena and sphalerite concentrates. The production from the Gribble-Harker mines was comparatively small, and the Rajah mine owned by the Mineral Point Zinc Co. was abandoned.

Livingston district.—The production of sphalerite in the district increased from 9,624 tons in 1912 to 11,940 tons in 1913, and the district was the third largest producer of sphalerite in Wisconsin.

The Coker mine of the Mineral Point Zinc Co. was operated steadily throughout the year and made a large production of sphalerite. Two shafts were used to hoist ore which was treated at a 200-ton mill. Both the Ellsworth mine on land owned by the Mineral Point Zinc Co. and a new mine on the Rundell land were worked by the Vinegar Hill Zinc Co. The 100-ton mill at the Ellsworth mine was run double shift (20 hours), treating "dirt" from both mines. A tramway was built from the Rundell mine to the mill and other surface improvements were made. The combined production of sphalerite was one of the largest in the State.

Mifflin district.—The output of Mifflin district in 1913 was 44 tons of galena concentrates, valued at $2,291, and 4,461 tons of sphalerite concentrates, valued at $105,672. The shipments of galena in 1913 were only 47 tons less than in 1912, but those of sphalerite decreased 3,952 tons. None of the mines are equipped with roasters, so that the sphalerite shipments consisted entirely of "green" concentrates. A considerable quantity of the concentrates made was not shipped in 1913, which partly accounts for the largely decreased output.

The Squirrel mine of the B. M. & B. Mining Co. was inactive part of the year, and the production was much less than in 1912. The shafts at this mine are 75 feet deep, and the concentrating plant has a capacity of 50 tons per shift.

The Peacock mine, on the Jenkin land, operated a 25-ton mill and was made the largest producer in the district. Three shafts of about 110 feet deep were in use during the year. The Grunow mine, on the Bainbridge land, was operated by means of a 104-foot shaft, and the ore was milled at a 75-ton concentrating plant. This mine was developed, the shaft sunk, and mill erected in 1913. A good production was made after the mill was put in operation.

The Peni mine was operated by means of a tunnel connected with a number of old shafts. The concentrating plant has a capacity of 75 tons and the sphalerite recovered averaged over 50 per cent zinc content. All the concentrates produced in 1913 were not shipped.

The output of concentrates by the Lucky Six Mining Co. on the Livingston land was about the same in 1913 as in 1912. The mine is operated by means of a 50-foot shaft and the 40-ton concentrating plant was electrically driven. A large portion of the waste rock broken was not hoisted to the surface, but was piled up in the workings to support the roof. Only about 80 per cent of the sphalerite recovered was shipped in 1913.

The Shamrock Mining Co. did considerable development work and shipped a quantity of sphalerite late in 1913. The lease is equipped with a 50-ton concentrating plant.

A very fair output of sphalerite was shipped from the Clayton Mining Co.'s lease on the Cushman & Nolan land. The ore was hoisted through a 110-foot shaft and concentrated by means of hand jigs. Operations were suspended on account of the low prices paid for sphalerite.

Mineral Point district.—The production of this district in 1913 was composed mainly of zinc carbonate. Only 37 tons of galena and

lead carbonate and 278 tons of sphalerite were shipped, while the zinc carbonate shipments amounted to 1,016 tons.

The Merry Christmas mine and 60-ton concentrating plant, owned by the Mineral Point Zinc Co., was only in operation from January to April, 1913. Nearly all the sphalerite and part of the galena shipped in 1913 came from this mine. The zinc carbonate came from what is known as the Barreltown camp and was purchased by the Mineral Point Zinc Co. from about 45 small operators. The carbonate ore was mined at shallow levels and the zinc content of the concentrates assayed from 13.91 per cent to 41.18 per cent. The largest producers in 1913 were the May Mining Co., Davis & Kinsman, W. Mitchell & Son, Prince & Austin, J. Grange, Ross & Doney, Perry & Suthers, D. & G. Williams, and R. Ellsworth.

Montfort district.—The shipments of sphalerite concentrates in 1913 were about the same as in 1912. The O. P. David Mining Co. was again the largest producer. The ore, which is of good grade, was hoisted by means of two shafts, each 127 feet deep, and concentrated at a 60-ton mill. A new shaft was sunk and a surface tramway 1,200 feet long was built from the shaft to the concentrating plant. The properties of the Nagle Mining Co. and of the United Mining Construction & Manufacturing Co. were idle all year.

Platteville district.—The mine production of sphalerite in this district in 1913 was 2,061 tons less than in 1912, and only the very large production from the East End mine, which made an increased yield of over 5,000 tons, prevented the district from showing a decrease of 50 per cent in output. The Homestead, Klar Piquette, Grant County, and Empire mines, formerly large producers, all reported less sphalerite shipped in 1913 than in 1912. The ore body in the famous Empire mine was finally exhausted so that the Wisconsin Zinc Co. operated only the East End mine in the Platteville camp. The mine which was purchased late in 1912 was operated steadily throughout 1913. The production of sphalerite was one of the largest in the State and most of the concentrates were sufficiently high in zinc content for shipment direct to smelters. The ore was mined from a depth of about 110 feet through two shafts and concentrated at a 100-ton plant.

The Grant County mine, which was operated by J. M. Nelson for a short time, made only a few hundred tons of sphalerite concentrates. The Homestead mine on the Shepherd estate, which was equipped with a 150-ton mill and a roasting and separating plant, was closed down most of the year. The output from the Klar Piquette mine in 1913 was much less than it was in 1912. A new 100-foot shaft was sunk on the Weigle land and other improvements made. The old Hodge (Mound City) and Enterprise mines in the city of Platteville were idle most of the year, and only small ore shipments were made. Small shipments of lead or zinc concentrates were made by Thurber Bros. of Calamine, McCoy & Bell of Platteville (St. Rose tailings), and by the Wilson Mining Co. operating at Potosi. The Wilson mine is equipped with a 75-ton mill. Prospect and development work only was done by the West Hill Mining Co. and the Belmont Zinc Co.

Shullsburg district.—The shipments of galena concentrates in 1913 were about the same in quantity as in 1912 and the shipments of sphalerite concentrates decreased 239 tons. The Rodham mine, which

has been one of the largest producers of galena in Wisconsin, shipped two-thirds of the galena and some zinc concentrates. The mine and 25-ton mill were operated by the Rodham Mining Co. until May, 1913. The leasehold was then acquired by Schreier Steffen & Co. and operations continued until September when the plant was closed down.

The Milwaukee-Shullsburg Mining Co. on the Frank Rouse land produced some lead and 64 per cent of the sphalerite shipped in 1913. The mine, which has a 130-foot shaft and is equipped with a mill of 50 tons capacity, was supplied with additional surface equipmennt.

The Brown-Croft mine of the Iron River Leasing Co. was idle most of the year and the shipments made were small. Some ore was hoisted and treated at the Farrey Queen mine, but no sales of ore were made.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES.[1]

Adams, G. I., Zinc and lead deposits of northern Arkansas: Bull. 213, pp. 187–196, 1903. 25 cents.

Adams, G. I., and others, Zinc and lead deposits of northern Arkansas: Prof. Paper 24, 118 pp., 1904. 40 cents.

Bain, H. F., Lead and zinc deposits of Illinois: Bull. 225, pp. 202–207, 1904. 35 cents.

——— Lead and zinc resources of the United States: Bull. 260, pp. 251–273, 1905. 40 cents.

——— Zinc and lead ores in 1905: Mineral Resources U. S. for 1905, pp. 379–392, 1906. $1.

——— Zinc and lead deposits of northwestern Illinois: Bull. 246, pp. 56, 1905. 15 cents.

——— Zinc and lead deposits of the upper Mississippi Valley: Bull. 294, 155 pp, 1906. 75 cents.

——— Reported gold deposits of the Wichita Mountains, Okla.: Bull. 225, pp. 120–122, 1904. 35 cents.

Bain, H. F., Van Hise, C. R., and Adams, G. I., Preliminary report on the lead and zinc deposits of the Ozark region: Twenty-second Ann. Rept., pt. 2, pp. 23–228, 1902. $2.25.

Bain, H. F., and Ulrich, E. O., The copper deposits of Missouri: Bull. 260, pp. 233–235, 1905. 40 cents.

Butler, B. S., and Siebenthal, C. E., Silver, copper, lead, and zinc in the Central States in 1909 (mine production): Mineral Resources U. S. for 1909, pt. 1, pp. 495–531, 1911. 60 cents.

Butler, B. S., and Dunlop, J. P., Silver, copper, lead, and zinc in the Central States in 1910 (mine production): Mineral Resources U. S. for 1910, pt. 1, pp. 611–668, 1911. 75 cents.

——— Silver, copper, lead, and zinc in the Central States in 1911 (mine production): Mineral Resources U. S. for 1911, pt. 1, pp. 793–872, 1912. 90 cents.

——— Silver, copper, lead, and zinc in the Central States in 1912 (mines report): Mineral Resources U. S. for 1912, pt. 1, pp. 437–521, 1913.

Clerc, F. L., The mining and metallurgy of lead and zinc in the United States. Mineral Resources U. S. for 1882, pp. 358–386, 1883. 50 cents.

Ellis, E. E., Zinc and lead mines near Dodgeville, Wis.: Bull. 260, pp. 311–315, 1905. 40 cents.

Grant, U. S., Zinc and lead deposits of southwestern Wisconsin: Bull. 260, pp. 304–310, 1905. 40 cents.

Grant, U. S., and Burchard, E. F., Geol. Atlas Lancaster-Mineral Point folio (No. 145), 1907. 5 cents.

Irving, R. D., The copper-bearing rocks of Lake Superior: Mon. 5, 464 pp., 1883. $1.85.

[1] The publications for which a price is given are no longer available for free distribution but can be purchased from the Superintendent of Documents, Washington, D. C.; others can be obtained free on application to the Director of the United States Geological Survey. Some are out of print but may be examined in libraries.

LINDGREN, WALDEMAR, Resources of the United States in gold, silver, copper, lead, and zinc: Bull. 394, pp. 114–156, 1909. 40 cents.

——— Tests for gold and silver in shales from western Kansas: Bull. 202, 21 pp., 1902. 5 cents.

SIEBENTHAL, C. E., Mineral resources of northeastern Oklahoma: Bull. 340, pp. 187–228, 1908. 30 cents.

SMITH, W. S. T., Lead and zinc deposits of the Joplin district, Missouri-Kansas: Bull. 213, pp. 197–204, 1903. 25 cents.

SMITH, W. S. T., and SIEBENTHAL, C. E., Geol. Atlas, Joplin district folio (No. 148), 1907. Out of print.

ULRICH, E. O., and SMITH, W. S. T., Lead, zinc, and fluorspar deposits of western Kentucky: Bull. 213, pp. 205–213 (25 cents), 1903; Prof. Paper 36, 218 pp., 1905.

VAN HISE, C. R., and LEITH, C. K., The geology of the Lake Superior Region: Mon., vol. 52, 1911. $2.50.

WINSLOW, ARTHUR, The disseminated lead ores of southeastern Missouri: Bull. 132, 31 pp., 1896. 5 cents.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES IN 1913.

(MINES REPORT.)

By H. D. McCaskey.

INTRODUCTION.

In the following pages is given a brief review of the gold, silver, copper, lead, and zinc mining industries in the Eastern or Appalachian States for the calendar year 1913. The area covered lies, for the greater part, immediately east of the Blue Ridge and its extensions, and is mainly coincident with the broad belt of old metamorphic and associated igneous rocks extending southwestward from Canada to Alabama. The zinc-lead belt of southwestern Virginia and eastern Tennessee, however, whose rocks are mainly Cambrian and Ordovician limestone and conglomerate, lies to the west of this great belt.

References have been given in previous reports to the most important papers on these mines in the Eastern States, and the geologic relations have, in most cases, been briefly described. In the report for 1914, which may be of special interest to visitors interested in mining at the Panama-Pacific Exposition, a full treatment of the subject is planned. At the end of the present report are given lists of the most important Survey publications on gold, silver, copper, lead, and zinc, of interest to those mining these metals in the Eastern States.

PRODUCTION.

The total value of the mine output of gold, silver, copper, lead, and zinc in the Eastern orAppalachian States in 1913 was $13,753,557, against a corresponding value of $13,470,276 in 1912 and of $11,787,942 in 1911—an increase over 1912 of $283,281 and over 1911 of $1,962,892.

The following table shows concisely the production of ore and recoverable metals of the Eastern or Appalachian States from 1906 to 1913, inclusive.

Tonnage of ore treated and mine production of metals in the Appalachian States, 1906–1913.

Year.	Ore sold or treated.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1906	979,881	$236,731	89,088	18,849,605	9,750	141,282,000	$12,572,454
1907	906,103	239,902	85,661	20,307,180	140,599	119,176,000	11,396,153
1908	1,116,392	259,143	66,170	19,880,894	76,190	136,429,800	9,333,902
1909	1,322,849	155,940	66,912	20,354,225	.....	166,328,859	11,818,531
1910	1,252,231	185,522	91,595	17,923,412	198,850	140,875,886	10,127,304
1911	1,258,144	159,370	108,105	19,605,386	834,742	159,351,558	11,787,942
1912	1,361,734	222,496	96,523	19,265,945	561,026	144,699,863	13,470,276
1913	1,603,539	165,733	111,205	19,964,729	1,632,000	184,898,400	13,753,557
Increase (+) or decrease (−) in 1913	+241,805	−56,763	+14,682	+698,784	+1,070,974	+40,198,537	+283,281

GOLD.

The total gold production was 8,017.33 fine ounces, valued at $165,733, a decrease of 2,745.91 ounces in quantity and of $56,763 in value for 1913. The placers yielded 733.65 ounces, against 774.83 ounces in 1912; the siliceous or gold-quartz ores 6,892.09 ounces, against 9,302.99 ounces in 1912; the copper ores 391.59 ounces, against 443.50 ounces in 1912; and the lead and lead-zinc ores produced no gold in 1913, against 241.92 ounces in 1912. The output of gold from all sources, therefore, decreased in 1913, notably that from deep gold mining, chiefly owing to decline in output from certain properties in North Carolina and South Carolina. From present information new developments in North Carolina bid fair to maintain an important production for some time to come. Nominal increases in gold output were made in Georgia and Virginia in 1913, but decline was reported from other producing States, notably from North Carolina and South Carolina.

SILVER.

The production of silver in the Eastern States in 1913 was 111,214 fine ounces, valued at $67,173, an increase of 14,691 fine ounces in quantity and of $7,812 in value over the corresponding production for 1912. The silver yield was a by-product from the refining of gold and copper produced in 1913, the bulk of it from the copper ores of the Ducktown district, Tenn., where there was an increase of 18,212 ounces over the output for 1912. There was no production reported of argentiferous lead-zinc ores from North Carolina in 1913, but over 1,700 ounces of silver were derived from the gold ores of that State.

Mine production of gold and silver in Eastern States in 1913, by States, in fine ounces.

State.	Gold.		Silver.		Increase (+) or decrease (−) in value compared with 1912.	
	Quantity.	Value.	Quantity.	Value.	Gold.	Silver.
Alabama	536.67	$11,094	117	$71	−$5,630	− $32
Georgia	730.85	15,108	75	45	+ 748	− 2
Maryland and Pennsylvania						− 309
North Carolina	6,116.92	126,448	1,812	1,095	−39,566	− 1,890
South Carolina	236.12	4,881	40	24	−12,034	− 5
Tennessee	367.41	7,595	108,105	65,295	− 670	+10,011
Vermont	.14	3	105	63	+ 3	− 63
Virginia	29.22	604	960	580	+ 386	+ 24
Total	8,017.33	165,733	111,214	67,173		
Increase (+) or decrease (−) in 1913	− 2,745.91	− 56,763	+ 14,691	+ 7,812	−56,763	+ 7,812

Source of gold and silver in Eastern States in 1913, by States, in fine ounces.

State.	Gold.			Silver.		
	Placers.	Dry or siliceous ores.	Copper ores.	Placers.	Dry or siliceous ores.	Copper ores.
Alabama		536.67			117	
Georgia	414.57	316.28		22	53	
North Carolina	308.53	5,808.39		35	1,777	
South Carolina	10.55	225.57			40	
Tennessee			367.41			108,105
Vermont			.14			105
Virginia		5.18	24.04			960
Total	733.65	6,892.09	391.59	57	1,987	109,170

COPPER.

The copper output of the Eastern States was 19,964,229 pounds in 1913, valued at $3,094,533, against a production in 1912 of 19,265,945 pounds, valued at $3,178,882. These figures show an increase for 1913 of 698,784 pounds in quantity and a decrease of $84,349 in value for the copper production of 1913. The great bulk of the output was, as usual, from the pyrite copper ores of the well-known Ducktown district of eastern Tennessee, the remainder coming chiefly from the copper-bearing magnetic iron ores of Cornwall, Pa., from copper ores of Vermont, and from the pyrite ores and mine waters of Virginia.

LEAD.

The production of lead in the Eastern States in 1913 was 1,632,000 pounds, valued at $71,808, an increase of 1,070,974 pounds in quantity and of $46,562 in value. The production was all from southwestern Virginia in 1913.

ZINC.

The zinc output of the Eastern States in 1913, figured as spelter, was 184,898,400 pounds, valued at $10,354,310, an increase of 40,198,537 pounds in quantity and of $370,019 in value over the corresponding production for 1912. The output was, as usual, mainly from New Jersey, but a constantly increasing production has been coming from eastern Tennessee in recent years and a steady output has been made from southwestern Virginia for many years. Small yields in 1913 were also reported from reduction of ore mined in New Hampshire and North Carolina in earlier years.

The value of the zinc output of the Eastern States was more than three times the value of the combined production of gold, silver, copper, and lead in 1913.

Mine production of copper, lead, and zinc in Eastern States in 1913, by States, in pounds.

State.	Copper.		Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
New Jersey					168,244,000	$9,421,664
New Hampshire					30,000	1,680
North Carolina					20,400	1,142
Pennsylvania and Vermont	517,692	$80,243				
Tennessee	19,390,750	3,005,566			11,166,000	625,296
Virginia	56,287	8,724	1,632,000	$71,808	5,438,000	304,528
Total	19,964,729	3,094,533	1,632,000	71,808	184,898,400	10,354,310
Increase (+) or decrease (−) in 1913	+698,784	−84,349	+1,070,974	+46,562	+40,198,537	+370,019

NUMBER OF MINES AND ORE OUTPUT.

There were 90 producing mines reported to the Survey in 1913, of which 42 were deep and 48 were placer properties. The latter are mostly small, some of them really yielding only nominal and occasional outputs of gold. In 1912 there were 93 reported producers, of which 43 were deep mines. Of the 42 deep mines in 1913, those producing copper number 7, those producing zinc (and in one case lead also) numbered 9, and the remainder were gold mines. The largest number of operating properties were in Georgia in 1913, where there were 27 gold placers and 12 deep mines, or 39 in all. North Carolina led in number of producers in 1912 with 36, of which 22 were placers. In 1913 North Carolina had but 24 producers, of which 17 were placers.

The total quantity of ore sold or treated in 1913 was 1,603,539 short tons, of which 18,883 tons were gold-quartz ores, 892,308 tons were copper and copper-bearing iron ores, and 692,348 tons were zinc ores (including a small quantity of lead-zinc material). In 1912 the total quantity of ores sold or treated was 1,361,734 short tons, of which 33,813 tons were gold-quartz, 830,089 were copper and copper-bearing iron, and 497,832 were zinc and lead-zinc ores. There was a considerable increase of total tonnage for 1913, therefore, of copper and particularly of zinc ores, but a marked decrease of gold-quartz ores sold or treated. The gold-quartz ores were mainly from North Carolina and Alabama in 1913 (the output from South Carolina having materially decreased), and the bulk of the copper ores were from the Ducktown district of Tennessee, the remainder being chiefly the copper-bearing magnetites of the Cornwall mines in Pennsylvania. The bulk of the zinc ores is from New Jersey, but there was a large increase from Tennessee in 1913.

The gold-quartz ores yielded an average precious metal recovery per ton of $7.66 in 1913, against $5.73 in 1912. The average yield in North Carolina was $10.83 in 1913 and $10.62 in 1912. The copper ores averaged a recovery of $0.08 in precious metals in both years, and 22.37 pounds of copper per ton in 1913, against 23.1 pounds in 1912. The zinc ores yielded no precious metal recoveries, but 267.1 pounds of zinc per ton in 1913 against 290.7 pounds in 1912.

Total number of producing mines, ore production, and average value of gold and silver per ton in Eastern States in 1913, by States, in short tons.

State.	Number of mines.			Ore production from deep mines and average recovered value in gold and silver per short ton mined.						
	Placer.	Deep.	Total.	Total production.	Dry or siliceous ores.		Copper ores.		Zinc ores.[a]	
					Quantity.	Average value.	Quantity.	Average value.	Quantity.	Average value.
Alabama	.....	4	4	4,068	4,068	$2.74	.....	.....	.....	.....
Georgia	27	12	39	2,614	2,614	2.51	.....	.....	.....	.....
New Hampshire	.....	1	1	400	.....	.....	.....	.....	400	.....
New Jersey	.....	1	1	490,434	.....	.....	.....	.....	490,434	.....
North Carolina	17	7	24	11,274	11,186	10.83	.....	.....	[b] 88	.....
Pennsylvania and Vermont	.....	3	3	239,178	.....	.....	239,178	$0.003	.....	.....
South Carolina	4	2	6	1,010	1,010	4.64	.....	.....	.....	.....
Tennessee	.....	5	5	823,645	.....	.....	652,253	.112	171,392	.....
Virginia	.....	7	7	30,916	5	21.40	877	1.228	[b]30,034	.....
Total	48	42	90	1,603,539	18,883	7.66	892,308	.08	692,348	.....

[a] No recovery of gold or silver from zinc ores. [b] Includes lead-zinc ores.

Number of copper, lead, and zinc producing mines, ore tonnage, and average pounds of metal recovered per short ton of ore in Eastern States in 1913, by States.

State.	Number of mines.		Copper ore.		Lead ore.		Zinc ore.	
	Copper.	Zinc.	Quantity.	Average per ton of ore.	Quantity.	Average per ton of ore.	Quantity.	Average per ton of ore.
New Hampshire	.....	1	.....	.....	.....	.....	400	.....
New Jersey	.....	1	.....	.....	.....	.....	490,434	343.1
North Carolina	.....	1	.....	.....	.....	.....	88	233.2
Pennsylvania and Vermont	3	.....	239,178	2.16	.....	.....	.....	.....
Tennessee	2	3	652,253	29.73	.....	.....	171,392	65.1
Virginia	[a] 2	[b] 3	877	64.18	.....	73.6	[c] 30,034	181.0
Total	7	9	892,308	22.37	.....	73.6	692,348	267.1

[a] Part of copper from mine water. [b] Includes lead and zinc mines. [c] Includes lead-zinc ores.

PRECIOUS AND SEMIPRECIOUS METAL INDUSTRY IN THE EASTERN STATES.

The few larger gold mines of the Carolinas, Alabama, and until recently of Georgia, have been operating more or less continuously and have produced the bulk of the gold output of the Eastern States. Some of these mines have been closed; others have fallen off in production during the last few years and appear to have passed their maximum output. On the other hand, new development and equipment, in North Carolina especially, has brought several old and new properties to a stage justifying the hope of considerably increased output. The small placers, especially in Georgia and North Carolina, represent a nominal but continuous production of gold. The lands in the South are mainly agricultural, and farming is done on the surface of many of the mining properties. Apparently the placer output is now steadily on the decline and the operations are mainly intermittent and incidental. Undoubtedly much placer gold remains in the gravels of the mountain streams and especially in the saprolite or weathered rock in place, and from time to time new and systematic development may cause a temporary increase in the placer output of the South. But the richest gravels have probably been largely worked out and it is known that some of them have been worked over several times. In general, therefore, it would seem that gold mining has by no means ceased in the South and that the working of old or undeveloped deposits may yet prove profitable if strictly efficient and economical methods be employed and the adaptation of proved metallurgical processes be found suitable; but it must be remembered that the Southern gold fields have been worked for many years, that the greater part of the pay gravels are probably exhausted, that the greater part of the known ore bodies have been worked below the oxidized free-milling zone, and that, therefore, success in mining investments is contingent upon a thorough understanding of ore deposits to be mined, of methods and costs, and of the integrity and skill of the personnel to be employed.

It has been repeatedly complained that the South has been the dumping ground of fancy machinery and patent "processes" for extracting gold and other metals, and the victim of inefficiency,

ignorance, and sharp practice in working its ore deposits. Large sums have undoubtedly been lost in mining ventures in the South and wrecks of futile or dishonest promotions are undoubtedly to be found. But the South is not alone in these bitter experiences of wasted money and effort, the old, familiar story being much the same from Alaska to Patagonia. Gradually business sense in mining ventures, comparable to that exercised in mercantile pursuits, has been developed, and prospective investors have profited to a growing extent by the publicity now so largely given to inefficiency and dishonesty in all walks of life. Mining in the South, as elsewhere, rests, in general, upon a more intelligent basis than ever before, and it is hoped that investors in the South, as elsewhere, will insist upon thorough understanding of the problems and business efficiency in mining as in other pursuits.

The copper production is chiefly from two large mines with steady output in Tennessee, and the zinc production is chiefly from a single famous producer in New Jersey. In Virginia, however, there continues annually a production of lead and zinc from the old Wythe County mines, and an important and rapidly increasing output of zinc is coming from eastern Tennessee. The lead production in the Eastern States has been relatively insignificant of recent years.

Changes for 1913 in Appalachian mining of precious and semiprecious metals were chiefly a decrease in placer output; a falling off in the production of the Hog Mountain, Haile, and Iola gold-quartz mines of Alabama, South Carolina, and North Carolina, respectively; new development and equipment promising increased output at the Uwharrie, Coggins, Howie, and other gold mines in North Carolina; and large increases in the zinc production of New Jersey and Tennessee and in the lead output of Virginia.

REVIEW BY STATES.

ALABAMA.

The mine production of gold in Alabama in 1913 was $11,094, against $16,724 in 1912, and the by-product of silver was 117 fine ounces against 168 ounces in 1912. The total value of the production of precious metals was $11,165, against $16,827 in 1912. No copper, lead, or zinc production has been reported from Alabama in recent years.

The following table shows the mine production of gold, silver, and copper in Alabama since 1905, when the United States Geological Survey first collected detailed figures from the mines of the Eastern States:

Tonnage of ore treated and output of metals in Alabama, 1905–1913.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	
1905	16,425	$41,530	336	.....	$41,733
1906	8,565	24,921	124	.....	25,004
1907	18,400	25,982	139	84,678	43,208
1908	11,174	41,208	282	.....	41,357
1909	9,886	29,239	212	.....	29,349
1910	9,763	33,533	268	.....	33,678
1911	6,360	18,916	171	.....	19,007
1912	5,693	16,724	168	.....	16,827
1913	4,068	11,094	117	.....	11,165
Decrease in 1913	1,625	5,630	51	.....	5,662

[a] Includes placer gold and silver.

The production for 1913 was from 4,068 short tons of siliceous ore with an average recoverable precious metal value of $2.74 per ton, against 5,693 tons and a recovery of $2.96 in 1912 and 6,360 tons and a recovery of $2.99 in 1911.

In Clay County, near Pyriton, are several pyrite mines, all idle in 1912 and 1913, whose ores formerly sold for their sulphur content and produced residues containing gold, silver, and copper. It is reported that the property of the Southern Mineral Development Co., at Pyriton, contains a large deposit of crystalline granular pyrite capable of producing first-class ore for acid manufacture, but that its development awaits a market for the ore. One assay is reported to show a content of 4.89 per cent of copper, and of $1.60 in gold per ton of the ore.

No operations were reported from the Gold Ridge prospects in Cleburne and Randolph counties. At the old Arbacoochee placers on Clear Creek, in Cleburne County, the erection of a plant for washing the gold gravels was reported for 1913.

At the Storey mine, near Waldo in Talladega County, a small tonnage treated by the Warwick Mining Co., in a 10-ton 5-stamp mill, produced gold by amalgamation. The ore is siliceous and occurs in veins and lenses in the metamorphic schists. At the Hog Mountain mine, near Alexander City, in Tallapoosa County, a similar tonnage was treated in a 75-ton cyanidation and blanket-concentration plant, after crushing in rolls and tube mill. Concentrates made contained about 6.2 per cent of bismuth, but this was not paid for by the purchasers. The greater part of the ore treated was unoxidized, but a portion was from the oxidized zone, which extends from 40 to 60 feet from the surface. The veins are of quartz in intrusive granite, and a little pyrrhotite is reported present. The property was operated part of the year on a lease, for experimental purposes, and the remainder of the time by the owner, the Hog Mountain Gold Mining Co. The old mine of the Dutch Bend Mining Co., also near Alexander City, has remained idle for several years because of litigation, but it is reported that an early settlement is in sight and that there is prospect of an early resumption of operations at the mine and mill.

GEORGIA.

The production of gold in Georgia in 1913 was $15,108, against $14,360 in 1912, and that of silver was 75 fine ounces, against 77 ounces in 1912. This gives a total precious-metal output for Georgia in 1913 of $15,153, against $14,407 in 1912 and $35,182 in 1911. There has been a general decrease in gold output in Georgia for several years past, and no production of copper, lead, or zinc has been made in recent years.

The following table shows the production for the years 1905 to 1913, inclusive:

Tonnage of ore treated and mine production of metals in Georgia, 1905–1913.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	16,000	$96,910	1,040	8,841	19,394	$103,400
1906	2,150	31,050	599	26,198	9,750	37,065
1907	4,727	64,808	864	22,800	14,400	70,701
1908	6,196	56,207	200	.....	.....	56,313
1909	8,549	60,620	202	.....	.....	60,725
1910	13,562	35,602	335	.....	.....	35,783
1911	3,737	35,070	212	.....	.....	35,182
1912	1,359	14,360	77	.....	.....	14,407
1913	2,614	15,108	75	.....	.....	15,153
Increase (+) or decrease (−) in 1913	+1,255	+748	−2	.....	.....	+746

[a] Includes placer gold and silver.

There were 28 placers and 11 deep mines reported as producing gold and silver in Georgia in 1913, against 23 placers and 5 deep mines in 1912. From the placers were produced 414.57 fine ounces of gold and 22 fine ounces of silver, against 331.18 ounces of gold and 23 ounces of silver in 1912. The deep mines (all gold quartz) produced 316.28 ounces of gold and 53 ounces of silver in 1913, against 363.49 ounces of gold and 54 ounces of silver in 1912. The deep mines produced 2,614 short tons of siliceous gold ores in 1913, against 1,359 tons in 1912, which yielded an average precious-metal recovery of $2.51 per ton in precious metals in 1913, against $5.53 per ton in 1912.

The following table shows the production of gold and silver in Georgia by counties in 1913:

Mine production of gold and silver in Georgia, 1913, by counties, in fine ounces.

County.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
Barton and Dawson	65.74	$1,359	5	$3	$1,362
Cherokee	21.76	450	3	2	452
Cobb, Milton, and McDuffie	46.40	959	6	4	963
Douglas, Haralson, and Paulding	150.35	3,108	24	14	3,122
Habersham and Hall	12.91	267	2	1	268
Lincoln and Wilkes	12.73	263	.....	.....	263
Lumpkin	198.63	4,106	16	10	4,116
White	222.33	4,596	19	11	4,607
Total 1913	730.85	15,108	75	45	15,153
Total 1912	694.67	14,360	77	47	14,407

Bartow County.—A nominal output of gold was reported from the McMechen and Parham prospect, near Allatoona, in Bartow County, in 1913.

Carroll County.—There was no production of precious metals or copper reported from Carroll County in 1913, but near Villa Rica are a number of mines producing pyrite for the manufacture of sulphuric acid. It has been reported that the Jennie Stone property will be equipped with a mill to treat the free-milling gold ore, and some development and construction work was done in 1913.

Cherokee County.—The production of Cherokee County in 1913 was 21.76 fine ounces of gold, valued at $450, against 26.17 ounces, valued at $541, in 1912, and a gold output valued at $1,715 in 1911. The yield of gold has therefore become insignificant since the closing down of the Franklin mine in 1909. Small quantities of placer gold are still obtained annually on the Franklin properties by sluicing, but the principal recent activity has been in the development of pyrite ore bodies. At the old Sixes mine there was no quartz mining in 1913, but a nominal output of placer gold was reported. A small production was also reported from the Worley mine in 1913.

Cobb County.—Near Acworth, in Cobb County, a nominal output of placer gold was reported in 1913.

Dawson County.—In Dawson County, the Taylor Creek, or McKee mines, near Dawsonville, produced a small yield of placer gold in 1913.

Douglas County.—The Pine Mountain saprolite deposit, in Douglas County, yielded a nominal output of gold from rockers in 1913.

Gilmer County.—No production of gold has been reported from Gilmer County for several years but one of several outlying auriferous areas of limited extent, considerably to the northwest of the main Georgian gold belts, lies about Whitepath in the center of the county. A number of undeveloped veins, carrying gold and associated sulphides, with or without quartz, and cutting the metamorphic country rock or interfolded with it, are found in this area, but their value is not reported. Small areas of gravel and saprolite (disintegrated rock in place) are known to be auriferous, even in terraces considerably above the present stream beds, and some of them have been worked as long as 50 years ago and most of them have been reworked at intervals since. The unworked gold-bearing areas are thought to be of limited extent by Phalen;[1] on the other hand, sufficient gold may remain in favorable localities to justify further working. Of course, as in all other mining, a thorough preliminary investigation should precede the expenditure of considerable sums for development and the work itself should be done to the degree of economical management and technical efficiency required to make any business venture a success. Notes on past production and descriptive of this area have been published by the Geological Survey of Georgia.[2]

Habersham and Hall Counties.—A nominal output of gold was made from prospecting in Habersham and Hall counties in 1913.

Haralson County.—At the Royal mine, near Tallapoosa, in Haralson County, a 100-ton cyanide plant was reported completed in 1913.

[1] LaForge, L., and Phalen, W. C., U. S. Geol. Survey Geol. Atlas, Ellijay folio (No. 187), p. 13, 1913.

[2] Yeates, W. S., McCallie, S. W., and King, F. P., A preliminary report on a part of the gold deposits of Georgia: Georgia Geol. Survey Bull. 4-A, pp. 254-261, 1896. Also Jones, S. P., Second report on the gold deposits of Georgia: Georgia Geol. Survey Bull. 19, pp. 269-272, 1909.

The mine is developed by incline shaft and drifts and development work in 1913 was with the view of opening up ore for the mill as the large tailings dumps first to be cyanided were found lean on the top and filled with organic matter and less suitable to cyanidation than at first supposed. The mill is provided with crusher, 750-pound stamps, and tube mill. The plant was not active in 1913. The Georgia Gold Mining Co. made a small output of placer gold from sluicing bench gravels on Tallapoosa River about 3 miles north of Tallapoosa. The work was mainly in testing the value of the property of 472 acres.

Lincoln County.—A small quantity of gold was produced from milling surface ore in a 5-head 250-pound stamp mill at the Edmunds property, and there was a nominal output from prospecting the Green mine in Lincoln County in 1913.

Lumpkin County.—The production of Lumpkin County was 198.63 fine ounces of gold, valued at $4,106, and 16 ounces of silver, valued at $10, in 1913, against a total value of gold and silver of $5,455 in 1912 and of $11,487 in 1911. Lumpkin and Cherokee counties, long the largest producers of Georgia, have greatly decreased their yield in recent years. In Lumpkin County especially, the Dahlonega and Auraria districts were notable producers in the past. In these districts there are still a considerable number of small placers, and operations, including prospecting, continued on a small scale at some of the gold quartz mines. The old Jumbo property changed ownership during the year and the 10-stamp mill was being prepared for operation upon oxidized free-milling ores.

McDuffie County.—There was a nominal output from prospecting the Shields property, in McDuffie County in 1913, but the Tatham, Hamilton, and Columbia mines were reported not in operation.

Milton County.—In Milton County small placer operations near Sheltonville resulted in a nominal output of gold in 1913.

Paulding County.—At the Peerless or Harper-Johnson property, in Paulding County, a 110-foot 2-compartment vertical shaft was sunk and north and south drifts were cut in development work in 1913. The plant is equipped with a 10-stamp mill and 2 Snodgrass washers, and the crude ore, composed of quartz stringers in micaceous schists, is reported free-milling to the bottom of the oxidation zone, 85 feet from the surface. Very little milling was done in 1913.

Rabun County.—At the Carleton prospects, in Rabun County, work preparatory toward operations in 1914 was done. Sinking and drifting was reported upon veins and ditches were cut for getting water on the bench gravels.

Union County.—Some prospecting was done upon the old mining properties near Blairsville, in Union County, but no production was reported in 1913.

White County.—The gold output of White County was 222.33 fine ounces, valued at $4,596, in 1913, and the total gold and associated silver production was $4,607, against $1,773 in 1912 and $12,151 in 1911. The Henderson and Longstreet properties were not worked in 1913, but the Loud placers, adjoining the Henderson on Town and Tesnatee creeks, about 3 miles from Cleveland, were again producers. The season was exceptionally dry, however, and sufficient water for hydraulicking was reported not available. Prospecting was reported at the Parks and other properties, and titles were acquired looking to other operations in 1914. The Calhoun placer, on Dukes Creek, and the Childs, near Sautee, were reported producing in 1913.

MAINE.

No production was reported from the Blue Hill or Cherryfield properties in Maine in 1913 and both were closed down during all the year.

MARYLAND.

The gold prospects in Montgomery County, Md., near the Great Falls of the Potomac, and the Liberty, New London, and Dolly Hyde copper properties near Frederick, were all reported idle in 1913. The two last-named properties, formerly operated by the Linganore Copper Co., are now controlled by the United Milling & Smelting Copper Co., which also controls the Eagle Metal property (another copper prospect in Adams and Franklin counties, Pa.). Considerable development and construction work has been done in recent years at the New London mine, which, with the Dolly Hyde and Old Liberty mines, had been worked for some years prior to 1839.[1] A small output of copper concentrates has been shipped at intervals in the last few years, prior to 1913, as the result of milling the New London ores.

MASSACHUSETTS.

At the Essex lead-silver prospect, near Newbury, a few tons of galena were mined but not sold in 1914. Considerable development work at this property is reported in prospect.

NEW HAMPSHIRE.

At West Ossipee, Carroll County, N. H., the property of the West Ossipee Mine Co. was leased to the New Hampshire Mining & Milling Co. in 1913, and preparations were reported for working in 1914. The Milan copper and pyrite mine, at West Milan, Coos County, was not operated during 1913. The Warren zinc mine at Warren, in Grafton County, was not operated, but small shipments were made of roasted fine concentrates resulting from work prior to the burning of the mill in 1905, and recovery of spelter was made at the experimental electric zinc smelting plant at Hartford, Conn.

NEW JERSEY.

There was no output from any of the various old copper mines of New Jersey in 1913.

The famous Mine Hill and Sterling Hill zinc mines, at Franklin Furnace and near Ogdensburg, N. J., respectively, were actively operated and produced an increased output of ore in 1913. The concentrating mills treated 351,151 short tons of ore, producing 286,553 short tons of concentrates. In addition, 139,283 short tons of ore were shipped. The total crude ore sold or milled in 1913 was, therefore, 490,434 short tons, against 459,585 tons in 1912 and 374,064 tons in 1911. The total recoverable zinc output in 1913 (figured as spelter) was 168,244,000 pounds, against 139,510,008 pounds in 1912 and 154,890,900 pounds in 1911.

The following table shows the zinc production of New Jersey for the years 1905 to 1913, inclusive.

[1] Whitney, J. D., Metallic wealth of the United States, pp. 317-318, Philadelphia, 1854. Quotes report of Dr. Ducatel, Maryland State geologist, p. 22, 1839.

Tonnage of ore treated and mine production of zinc in New Jersey, 1905–1913.

Year.	Ore sold or treated.	Zinc.	Total value.
	Short tons.	*Pounds.*	
1905	323,062	[a] 126,318,000	$7,452,762
1906	360,330	[a] 141,282,000	8,618,202
1907	329,205	[a] 119,176,000	7,031,384
1908	356,457	134,330,690	6,313,542
1909	475,838	165,020,071	8,911,084
1910	375,677	137,355,219	7,417,182
1911	374,064	154,890,900	8,828,781
1912	459,585	139,510,008	9,626,191
1913	490,434	168,244,000	9,421,664
Increase (+) or decrease (−), 1913	+30,849	+28,733,992	−204,527

[a] Estimate based on ore tonnage given by H. B. Kümmel, State geologist, and average per cent of zinc in ore.

NEW YORK.

The Phoenix lead-zinc prospect, near Otisville, N. Y., has been developed but has not yet produced, owing to lack of capital.

At the Edwards zinc and pyrite mine, in St. Lawrence County, described in this report for 1912, development work continued promising in 1913, according to report, and extensive experiments were made in treating the ore for which a new mill was in course of construction and was expected to be completed for operation in 1914.

The old Ellenville zinc mine in Ulster County has been idle for several years. The property is equipped with a 40-ton concentrating mill.

NORTH CAROLINA.

The mine production of North Caroline in 1913 was 6,116.92 fine ounces of gold, valued at $126,448; 1,812 fine ounces of silver, valued at $1,095; and 20,400 pounds of zinc, valued at $1,142. The output for 1912 was 8,030.93 fine ounces of gold, valued at $166,014; 4,854 fine ounces of silver, valued at $2,985; 75,915 pounds of copper, valued at at $12,526; 92,000 pounds of lead, valued at $4,140; and 283,320 pounds of zinc, valued at $19,549. The total value of the output was, therefore, $128,685 in 1913, against $205,214 in 1912, and $70,782 in 1911.

North Carolina furnished again in 1913 much the greater part of the gold output of the Eastern States, and the falling off in gold production of this region was largely due to the decline in North Carolina. Of the total production in the State, 17 placers (against 22 in 1912) produced 308.53 fine ounces of gold in 1913 (against 423.38 ounces in 1912). From 7 deep mines and prospects were produced 5,808.39 fine ounces of gold, 1,777 ounces of silver, and 20,400 pounds of zinc, against 7,607.55 fine ounces of gold, 4,819 ounces of silver, 75,915 pounds of copper, 92,000 pounds of lead, and 283,320 pounds of zinc in 1912. There were 11,186 short tons of siliceous gold ores treated in North Carolina in 1913 with an average precious-metal recovery of $10.83 per ton, against 14,358 tons with an average recovery of $10.62 in 1912.

The following table shows the production of gold, silver, copper, lead, and zinc in North Carolina for the years 1905 to 1913, inclusive:

Mine production of gold, silver, copper, lead, and zinc in North Carolina, 1905–1913.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	18,831	$125,685	20,230	480,000	.....	.....	$212,784
1906	20,368	82,131	30,769	703,775	.....	.....	238,575
1907	19,682	82,193	21,667	582,082	.....	.....	212,909
1908	9,088	97,495	1,260	19,393	.....	.....	100,723
1909	7,271	40,230	499	224,512	.....	.....	69,675
1910	14,914	68,045	9,053	140,514	.....	.....	90,778
1911	21,810	70,282	943	.....	.....	.....	70,782
1912	16,073	166,014	4,854	75,915	92,000	283,320	205,214
1913	12,274	126,448	1,812	.....	.....	20,400	128,685
Decrease in 1913	3,799	39,566	3,042	75,915	92,000	262,920	76,529

[a] Includes placer production.

There has been no output of copper, lead, and zinc in North Carolina in recent years until 1912, when there was a production of copper chiefly from the Cullowhee mine, in Jackson County, and of lead and zinc chiefly from the Silver Hill mine, in Davidson County. In 1913 there was a small output of zinc but none of copper or lead reported to the Survey.

The following table shows the production of gold and silver, by counties, in North Carolina in 1913:

Mine production of gold and silver in North Carolina in 1913, by counties.

County.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
Burke and McDowell	81.13	$1,677	12	$7	$1,684
Cabarrus	26.51	548	.....	.....	548
Caldwell and Iredell	20.32	420	5	3	423
Catawba and Gaston	19.59	405	2	1	406
Mecklenburg	23.99	496	3	2	498
Montgomery and Randolph	5,717.64	118,194	1,750	1,058	119,252
Rowan	52.20	1,079	13	8	1,087
Rutherford and Union	175.54	3,629	27	16	3,645
Total	6,116.92	126,448	1,812	1,095	127,543

Burke County.—There was a production of gold from the Brindletown placers, near Bridgewater, in Burke County, in 1913.

Cabarrus County.—The gold output of Cabarrus County was $548 in 1913, against $475 in 1912 and $1,567 in 1911. The production is mainly from small placer operations.

Caldwell County.—The Niebelung prospect, near Lenoir, in Caldwell County, made a small output of gold in 1913. The operations were by hydraulic washing and crushing in a 5-stamp mill. The deposits are described by the manager as free milling gold-quartz stringers in slates.

Catawba County.—A nominal output of gold was produced from the Wheeler-Edwards placer, in Catawba County, in 1913. The Shuford and other producers of recent years were reported idle.

Davidson County.—There were no operations reported at the Silver Hill and other old mines in Davidson County in 1913. At the Silver Hill the machinery of the plant was reported for sale. One carload of 40 per cent zinc concentrates, resulting from work of earlier years, was shipped from this mine in January.

Gaston County.—A nominal output of gold was reported from Gaston County in 1913.

Guilford County.—On the Dickens property, adjoining the old Fentress mine in Guilford County, a new shaft 70 feet deep, disclosing a considerable vein of quartz carrying gold associated with pyrite, is reported to have been sunk during 1913.

Iredell County.—A nominal output of gold was reported from small prospecting operations near Mooresville, Iredell County, in 1913.

Jackson County.—Operations were suspended during 1913 at the Cullowhee copper mine and matte furnaces near Webster, in Jackson County.

McDowell County.—A nominal production of placer gold was reported from near Dysartville, in McDowell County, in 1913.

Mecklenburg County.—There was a small output of surface gold in Mecklenburg County in 1913, one nugget being found in a cotton field during the picking season. The Piedmont dredge, on Catawba River, originally designed for recovery of gold but later used to produce gravel and sand for engineering construction works, was idle and the operators went out of business.

Montgomery County.—In Montgomery County some recent development work on the old Carter mine is reported to have disclosed three veins with promising values in gold. The property is on Little River and a suitable dam site and favorable outlook for water power are also reported there.

The well-known Iola, or Candor, mine, the largest gold producer for several years east of the Black Hills, made a somewhat decreased production in 1913, part of the output being from the reworking of old tailings. The principal vein strikes N. 41° E. and dips N. 45° W. The ore bodies are reported to dip out of Iola ground and into the Uwarra (Montgomery) territory on the northeast and the Martha Washington ground on the southwest. The Golconda vein, striking parallel to the Iola and lying southeast of it, appears to cross the Iola ground but has not been developed there. The Iola mine is opened by 5 shafts and extensive drifts to a depth of 650 feet, and is equipped with a 50-ton mill and modern cyanide plant. The stamps, weighing 1,750 pounds each, are the heaviest used in the United States. The equipment includes Dorr classifiers, tube mill, Parral agitators, and Kelly filters. The ore is both sulphide and oxidized. One statement of treatment costs gave $1.005 per ton for milling and $0.635 for cyaniding.

No operations were reported at the Martha Washington property, southwest of the Iola, in 1913, but machinery has been shipped there with the view to active development. The Iola vein both strikes and dips into this ground, according to reports, and is prospected there by 3 shallow shafts. To the northwest of this vein 500 feet is reported another vein 7 feet wide, dipping 70° to the northwest and apparently meeting the Iola vein in depth.

The Uwarra (old Montgomery) mine adjoins the Iola on the northeast and the workings are in an extension of the Iola vein. There are 2 shafts, one 400 feet deep, to the northwest of the outcrop. The property is developed by 5,000 feet of drifts, and was equipped in 1913 with a 50-ton fine grinding and cyaniding plant at a cost of $50,000. Crushing and grinding will be in cyanide solution and mechanical agitation will be practiced. The mine was operated continuously during 1913, but the mill did not begin operation on ore until the last day of the year.

The ownership of the Old Coggins mine has changed in recent years and the property was actively and very successfully developed in in 1913. The mine is now opened by an inclined shaft 268 feet deep (46 feet of which were sunk in 1913) and by about 1,000 feet of drifts and crosscuts. It is equipped with a 10-stamp amalgamation and concentrating plant erected in 1913 to replace the former plant destroyed by fire in 1912. The ore is crushed, stamped, amalgamated, and concentrated. The free gold is recovered, the gold-bearing sulphide concentrates are stored for shipment, and the tailings are impounded for future treatment. The present mill, with 10 stamps of 1,050 pounds each, and a daily capacity of 40 tons, is to be doubled in capacity, as the operators have been reported unusually successful in finding and treating high-grade ore since the close of 1913.

The Sallie Coggins prospect was idle in 1913. The property was originally worked in a small way for its free gold ores, but it is understood that sulphides predominate.

Randolph County.—The old Scarlett copper mine in Randolph County, near Ashboro, was under option to the Tennvanoca Copper Mining Co. in 1913, and some development work was reported. The Southern Homestake and other properties were idle, but development of these and several other prospects were in view. A nominal placer output was made in Randolph County in 1913.

Rowan County.—The gold production of Rowan County was $1,079 in 1913, against $1,585 in 1912 and $1,301 in 1911, and was chiefly from small sluicing operations. The Gold Hill and Union Copper mines at Gold Hill made no production, but in the latter part of the year work was resumed at both properties—development and unwatering at the Gold Hill mine and working over old dumps at the Union.

Rutherford County.—The Biggerstaff was again an active producer of placer gold in 1913.

Union County.—The production of Union County in 1913 was $3,629 in gold and 27 ounces of silver, valued at $16, or a total output valued at $3,645. The Wentz property, near Matthews, made a nominal output from prospect work. The Wyona-Davis-Price properties were not operated in 1913, but there was some prospect of development in 1914. The old Colossus or Howie mine, near Waxhaw, was actively developed for five months and is opened by a 355-foot vertical shaft and a 100-foot adit. The property is equipped with a 50-ton all-sliming cyanide plant, in which continuous agitation and decantation are practiced. The ore is sulphide with siliceous gangue and is oxidized to a depth of 40 feet. The mill was operated intermittently for about two months.

PENNSYLVANIA.

There has been no production of gold, silver, lead, or zinc ores reported from Pennsylvania for many years, but since 1912 there has been annually a copper production yielding small quantities of precious metals in refining. The greater part of the output has been a by-product separated from magnetic ores of the Cornwall iron mine.

The following table shows the quantity of ore producing copper, silver, and gold, and the metal output from 1907 to 1913:

Tonnage of ore treated and mine production of metals in Pennsylvania, 1905–1913.

Year.	Ore sold or treated.	Gold.	Silver.	Copper.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	
1905					
1906					
1907					
1908	[a] 57,269	$701		186,869	$25,371
1909	191,198	4,911	43	621,969	85,819
1910	218,183	5,640	50	927,360	123,442
1911	219,368			642,902	80,363
1912	214,000			473,060	78,055
1913	239,083			503,792	78,088
Increase, 1913	25,083			30,732	33

[a] Estimated.

Adams and Franklin counties.—In Adams and Franklin counties, near the Maryland line, are a number of copper prospects in which native metal with epidote and calcite associated with diabase has been found. None of these were productive in 1913, and operations were suspended. The Eagle Metallic, one of these properties, is now controlled by the United Milling & Smelting Copper Co., of Frederick, Md., which also controls the New London and the Dolly Hyde mines referred to in the notes on Maryland.

Lebanon County.—At the Cornwall iron mines, in Lebanon County, an important output of pyritiferous magnetite was again treated in a 1,000-ton concentrator by the Gröndahl process, resulting in briquetted copper-bearing pyrite, which was shipped to copper smelters, and in clean, high-grade magnetite.

SOUTH CAROLINA.

The mine production of gold in South Carolina was 236.12 fine ounces, valued at $4,881, and that of silver was 40 ounces, valued at $24, a total value of the precious metal output of $4,905 and a decrease of $12,039 from the total value of $16,944 in 1912. There has been no output of copper, lead, or zinc reported in South Carolina in recent years. The yield of 1913 was again mainly from deep mines, only 10.55 fine ounces of gold and no silver being reported from two small placers. At four deep mines there were treated 1,010 short tons of siliceous ore, yielding an average recovery in precious metals of $4.64 per ton, against an output of 12,358 short tons from seven mines in 1912, with an average recovery of $1.34.

The gold output of South Carolina has been steadily decreasing, as shown in the following table giving the production for the years 1905 to 1913, inclusive:

Tonnage of ore treated and mine production of metals in South Carolina, 1905–1913.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	
1905	49,493	$95,111	111	.....	$95,178
1906	49,327	78,959	92	.....	79,021
1907	36,195	54,765	124	.....	54,847
1908	16,795	53,715	226	1,600	54,046
1909	3,150	11,053	44	.....	11,076
1910	24,153	38,324	46	.....	38,349
1911	9,302	20,408	11	.....	20,414
1912	12,358	16,915	47	.....	16,944
1913	1,010	4,881	40	.....	4,905
Decrease, 1913	11,348	12,034	7	.....	12,039

[a] Includes placer gold and silver.

Abbeville County.—At the Neel property, near Abbeville, in Abbeville County, a small tonnage of ore was again treated in a light stamp mill, but the plant was closed down after a short run for lack of equipment to save the sulphides which constitute more than two-thirds the value of the ores. The mine was prospected only in 1913. The Donalds Copper Mining Co. was engaged in prospecting in Abbeville, but did not ship. The Hawk Woods property was prospected by shallow shafts and two veins were exposed.

Cherokee County.—At the old Knott placer, near Gaffney, in Cherokee County, a nominal output was made in 1913. At the Flint Hill property construction of a plant to include a 40-ton Lane mill was begun.

Lancaster County.—The Haile mine, near Kershaw, in Lancaster County, continued production in 1913 with a considerably reduced output. A new cyanidation plant, equipped for continuous agitation and decantation and with a daily capacity of 40 to 50 tons, was completed in 1913 and operated on old tailings, of which there is a large supply from operations of the old plant in former years. No ore was mined underground. The new plant is reported a success in the work for which it was designed.

Union County.—A small production of gold was made from the West placer in Union County in 1913.

York County.—The Almathea prospect, near Smyrna, in York County, produced a small tonnage of ore in 1913 from development work. The shaft is down 125 feet and shows sulphide ores carrying gold and small quantities of copper, with a quartz gangue.

TENNESSEE.

The production of precious metals in Tennessee in 1913 was 367.41 fine ounces of gold, valued at $7,595, and 108,105 fine ounces of silver, valued at $65,295, a decrease in value of gold production of $670, but an increase in value of silver output of $10,011. The production of copper was 19,390,750 pounds, valued at $3,005,566, and the output of zinc (figured as spelter) was 11,166,000 pounds, valued at $625,296. In 1912 the copper production was 18,483,173 pounds, valued at $3,049,724, and that of zinc was 4,381,300 pounds, valued at $302,310. The copper output, therefore, increased 907,577 pounds

in 1913 and the zinc production increased 6,784,700 pounds and was by far the largest output in the history of Tennessee. The net gain in value of gold, silver, copper, and zinc production was $288,169.

There have been no gold, silver, or lead mines producing in Tennessee in recent years, and the entire gold, silver, and copper output recorded was from 652,253 short tons of copper ores produced in the Ducktown district (against 603,229 tons in 1912), with an average precious metal recovery of $0.112 per ton against $0.105 in 1912, and with a copper recovery of 29.73 pounds per ton in 1913 against 30.6 pounds in 1912.

The zinc production was entirely from 171,392 short tons of zinc ore sold or treated, against 32,347 tons in 1912, which yielded an average of 65.1 pounds of zinc (figured as spelter), against 135.4 pounds in 1912, and no precious metals, per short ton of crude ore treated. There has been an extensive campaign of prospecting and development of zinc deposits in eastern Tennessee in recent years, and large bodies of ore have been located on the surface and underground, and several large zinc companies have been especially active in development and construction work. The outlook is for an important increase in the zinc production of Tennessee. Some lead prospecting has also been done in old and new fields, and there may be a revival of this industry in a small way, but the general outlook for important lead production in the Eastern States is not bright, from present knowledge.

The following table shows the output of Tennessee for the years 1905 to 1913, inclusive:

Tonnage of ore treated and mine production of metals in Tennessee, 1905–1913.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	399,330	$4,362	95,522	14,541,425	.....	$2,330,606
1906	538,141	4,838	55,931	17,979,317	.....	3,512,320
1907	561,805	3,825	58,358	18,983,115	218,643	3,833,864
1908	638,033	3,699	57,696	19,459,501	688,149	2,635,275
1909	611,014	4,118	57,637	19,206,806	1,192,161	2,595,350
1910	578,434	3,113	81,239	16,837,727	1,932,555	2,289,731
1911	604,538	11,621	106,660	18,850,276	2,234,000	2,551,774
1912	635,576	8,265	89,893	18,483,173	4,381,300	3,415,583
1913	823,645	7,595	108,105	19,390,750	11,166,000	3,703,752
Increase (+) or decrease (−) in 1913	+188,069	−670	+18,212	+907,577	+6,784,700	+288,169

[a] Includes placer gold and silver.

Jefferson County.—An important production of zinc was again reported from Jefferson County in 1913. The Loy mine, near Newmarket, developed by shallow shafts and open cuts, was in active operation and produced zinc carbonate ores which were concentrated in a mill whose capacity is rated at 150 tons per 10-hour shift. The equipment includes washers, crushers, rolls, jigs, and tables. The oxidation zone extends to a depth of 75 to 80 feet. The zinc content of the milling ore is reported to average about 12 per cent and that of the concentrates about 42 per cent.

Knox County.—The old Holston zinc mine, near Mascot, in Knox County, now known as the Mascot No. 1, has been extensively explored by drilling, and large quantities of zinc blende were reported developed by June, 1913, when active mining began. Development has since indicated ore reserves of 3,000,000 to 4,000 000 tons. One shaft is 385 feet deep and another 176 feet. Development work includes 8,000 feet of drifts and 3,000 feet of raises. The present concentration mill has a capacity of 1,100 tons in 24 hours and is equipped with crushers, jigs, and concentrating tables. The crude ore milled is reported to run from 3 to 5 per cent in zinc and to be a clean yellow blende with trace of cadmium and no lead and with calcite gangue in dolomite breccia. The concentrates produced average over 60 per cent zinc. A new mine, Mascot No. 2, on the old Evans ore body, is under active development, and large bodies of additional ore reserves of higher grade than at Mascot No. 1 are reported there. The shaft on No. 2, or the Evans mine, is over 612 feet deep. Additional milling capacity is also reported under consideration for the two Mascot mines, which are both operated by the American Zinc, Lead & Smelting Co. An important factor of the milling profits is that tailings can be sold for railroad ballast, road construction, concrete work, and roofing material, and the finer tailings for "liming" the soil for farming purposes, all at a price that will increase earnings from operations.

McMinn County.—An old lead prospect near Riceville, in McMinn County, was developed in 1913 by Cramer & Rolen, by 3 shallow shafts, and was reported to show promising lead ore carrying 1 ounce of silver to the ton and from 1 to 2 per cent of zinc. The ore is said to be in dark Knox dolomite breccia and the crevices to open out downward.

Polk County.—The Polk County, London, and Burra Burra mines of the Tennessee Copper Co., in the Ducktown district of Polk County, were actively operated again in 1913 and made important output of sulphide copper ores. The deposits are massive and worked by back stopes. The plant includes a 2,000-ton smelter with converters and equipment for recovery of sulphuric acid. The production of metals and acid was, as usual, large. The Mary, East Tennessee, and Isabella mines of the Ducktown Sulphur, Copper & Iron Co., producing ores similar to those of the Tennessee Co., were also actively worked and made a large output of ores, metals, and acid. The smelter has a capacity of 600 tons of ore per day, and recovery of sulphuric acid is also made.

Union County.—In Union County, the Tennessee-Oklahoma Oil Co. is reported to have mined a small quantity of ore averaging about 10 per cent zinc and 2 per cent lead during prospect and development work. Construction of a small mill was under consideration.

Washington County.—Near Embreeville, in Washington County, a considerable tonnage of zinc silicate ore was produced from open pits of the old Embree Iron Co. in 1913. The ore has been found to the depth of the hard dolomite, lying 20 to 100 feet from the surface, and occurs in residual clays beneath the overburden of soil and hematite and upon and between eroded pinnacles of the dolomite. The properties were worked for many years for the hematite iron

ores, and a 200-ton iron blast furnace has been intermittently in operation until 1908, producing pig iron. The iron ores were mined by hydraulic methods, and the removal of the iron led to the eventual discovery of the zinc beneath, although it had been known for many years that the hematite carried some zinc. The ores are sorted by hand in the pits and then sent to the concentrating plant, where they are washed, picked, and dried for shipment. Crude ore averaging 35 per cent in zinc is shipped, and that averaging 20 per cent is concentrated to a product averaging about 30 per cent. The crude ore is wet and the product as shipped is reduced to a moisture content of from 5 to 10 per cent.

VERMONT.

The old copper mines of Orange County, Vt., were all reported idle in 1913. From the Elizabeth mine, of the Vermont Copper Co., however, was shipped a small tonnage of old slag which resulted in a nominal output of copper, silver, and gold. An incline shaft has been sunk 342 feet, and drifts aggregating 877 feet, and 175 feet of adits were reported at this mine. From the Bicknell property, near Corinth, was also shipped a small tonnage of crude ore, resulting in a nominal output of copper and silver at the smelters, but, according to reports, the shipment was not profitable.

VIRGINIA.

The production of gold in Virginia was 29.22 fine ounces of gold, valued at $604, in 1913, against 10.54 ounces, valued at $218, in 1912, and 148.22 ounces, valued at $3,064, in 1911. The yield of silver was 906 ounces, valued at $580, in 1913, against 982 ounces in 1912, and 21 ounces in 1911. The production of copper decreased from 112,835 pounds, valued at $18,618, in 1912 to 56,287 pounds, valued at $8,724, in 1913, but the output of lead increased from 469,026 pounds, valued at $21,106, in 1912 to 1,632,000 pounds, valued at $71,808, in 1913. The production of zinc increased from 497,235 pounds, valued at $34,309, in 1912 to 5,438,000 pounds, valued at $304,528, in 1913.

Virginia had the largest output of lead and zinc in 1913 in many years, but the output of all the other metals, as shown above, was unimportant. Owing to the largely increased output of lead and zinc the total value of the production of the five metals in 1913 was $386,244, an increase over the total value for 1912 of $311,389, and the largest value since 1905, when separate figures of output were first recorded by the United States Geological Survey.

The small gold production of Virginia in recent years has been from deep mines and mainly from nominal tonnages of siliceous ores treated. The silver and copper were from pyritic copper ores and mine waters. The lead and zinc production was from 30,034 tons of zinc and lead-zinc ores in 1913, against an output of 4,585 short tons in 1912. Seven deep mines and no placers were reported productive in Virginia in 1913.

The following table shows the production of gold, silver, copper, lead, and zinc in Virginia from 1905 to 1913, inclusive:

Tonnage of ore treated and mine production of metals in Virginia, 1905–1913.

Year.	Ore sold or treated.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	800	$4,982	177	.....	.....	.....	$5,087
1906	1,000	14,832	250	.....	.....	.....	15,000
1907	26,822	8,288	221	58,880	118,400	.....	26,485
1908	12,877	2,451	236	24,775	76,190	1,410,961	75,361
1909	14,075	3,750	4,825	224,162	.....	116,627	41,698
1910	16,976	888	128	5,402	198,850	1,588,112	96,151
1911	17,782	3,064	21	90,000	830,542	2,064,818	169,394
1912	5,790	218	982	111,835	469,026	497,235	74,855
1913	30,916	604	960	56,287	1,632,000	5,438,000	386,244
Increase (+) or decrease (−) in 1913	+25,126	+386	−22	−55,548	+1,162,994	+4,940,765	+311,389

[a] Includes placer gold and silver.

Fauquier County.—The Emigold prospect, near Goldvein, in Fauquier County, again made a nominal output of gold in 1913. Some activity has recently been shown in prospecting old gold mines of Fauquier County near Morrisville, some of which were productive before the Civil War and most of which have been but little worked since. These include the Franklin, in which development has recently disclosed a quartz sericite vein carrying gold associated with pyrite and chalcopyrite. The Little Elliot and Liberty prospects, the latter near Pine View, have also been reported under recent development.

Louisa County.—At the Allah Cooper property, near Mineral, in Louisa County, considerable work was reported in 1913. A lead-zinc sulphide vein with siliceous gangue was developed and ore was placed on the dump. Cement copper was recovered and shipped, as usual, from mine waters of the Sulphur mine, which produces pyrite for the manufacture of sulphuric acid.

Prince William County.—The Cabin Branch pyrite mine, near Dumfries, again produced copper ore resulting in a recovery of copper and silver in 1913.

Rockingham County.—Prospecting near Timberville, in Rockingham County, disclosed a new deposit of zinc ore which was undeveloped late in 1913. The ore is reported to carry some lead and pyrite and to lie in a fault breccia in the Shenandoah limestone.

Spotsylvania County.—There was no production of ore nor output of metals in 1912 or 1913 from the mixed gold-silver-lead-zinc pyrite ores of the Grindstone or Holladay properties, which lie in a northeast extension of the pyritic mineral belt of Louisa County. Prospecting, however, was continued in 1913.

Wythe County.—There was an important and increased output of lead and zinc from the Austinville, Bertha, and Little Wythe mines in Wythe County in 1913. The Austinville mine produces both lead and zinc, and the Bertha and Little Wythe mines zinc only. The Austinville is developed by a vertical shaft 471 feet deep, by a 1,500-foot adit, and by 10,000 feet of drifts, and the mill has a capacity of 10 tons per 10-hour shift and includes crushers, Hancock and Hartz jigs, and tables. The coarse ore goes to Hancock jigs and the fine

to Hartz jigs and tables. The lead concentrates are shipped to smelters and the zinc to oxide furnaces. The ore is disseminated as sulphides of zinc, lead, and iron in a dolomite gangue and is oxidized to 235 feet. The crude milling ore averages over 5 per cent in zinc and 4 per cent in lead, and the lead and zinc concentrates each average over 19 per cent. At the Little Wythe property hand-sorted zinc ore averaging 40 per cent in zinc is recovered and shipped incidental to mining iron ores. At the Bertha mine old tailings averaging about 15 per cent in zinc are shipped to the Austinville plant for treatment. A new prospect, showing carbonates and silicates of zinc on an extension of the Bertha and Austinville belt, was reported promising in 1913, but remained undeveloped.

SURVEY PUBLICATIONS.

The following list contains the more important publications of the United States Geological Survey on gold, silver, copper, lead, and zinc mines of the Eastern States, or of interest in this connection. The Survey publications, except those to which a price is attached, can be had free so long as the stock remains available for distribution, by applying to the Director, U. S. Geological Survey, Washington, D. C. The priced publications can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Publications marked "exhausted" are not available for distribution but can be consulted at most of the larger public libraries.

Bain, H. F., Zinc and lead ores in 1905: U. S. Geol. Survey Mineral Resources, 1905, pp. 379–392, 1906. $1.

Bascom, F., Darton, N. H., Clark, W. B., Kümmel, H. B., and Salisbury, R. D., U. S. Geol. Survey Geol. Atlas, Trenton folio (No. 167), 1909. 5c.

Becker, G. F., Gold fields of the southern Appalachians: U. S. Geol. Survey Sixteenth Ann. Rept., pt. 3, pp. 251–331, 1895. $1.

Boutwell, J. M., Lead: U. S. Geol. Survey Mineral Resources, 1906, pp. 450–452, 1907.

——— Zinc: U. S. Geol. Survey Mineral Resources, 1906, pp. 465–468, 1907.

Butler, B. S., Copper: U. S. Geol. Survey Mineral Resources, 1908, pt. 1, pp. 214–219, 1909.

——— Copper: U. S. Geol. Survey Mineral Resources, 1909, pt. 1, pp. 171–172, 1910.

——— Copper: U. S. Geol. Survey Mineral Resources, 1910, pt. 1, pp. 206–211, 1911.

——— Copper: U. S. Geol. Survey Mineral Resources, 1911, pt. 1, pp. 255–313, 1912.

——— Copper: U. S. Geol. Survey Mineral Resources, 1912, pt. 1, pp. 275–334, 1913.

Campbell, M. R., U. S. Geol. Survey Geol. Atlas, Bristol folio (No. 59), 1899. 5c.

Clerc, F. L., The mining and metallurgy of lead and zinc in the United States: U. S. Geol. Survey Mineral Resources, 1882, pp. 358–386, 1883. 50c.

Darton, N. H., and Keith, Arthur, U. S. Geol. Survey Geol. Atlas, Washington folio (No. 70), 1900. Exhausted.

Eckel, E. C., Gold and pyrite deposits of the Dahlonega district, Georgia: U. S. Geol. Survey Bull. 213, pp. 57–63, 1903. 25c.

Emmons, W. H., Some ore deposits in Maine and the Milan mine, New Hampshire: U. S. Geol Survey Bull. 432, 62 pp. 1910.

——— The enrichment of sulphide ores: U. S. Geol. Survey Bull. 529, 260 pp. 1913. Exhausted.

Emmons, W. H., and Laney, F. B., Preliminary report on the mineral deposits of Ducktown, Tenn.: U. S. Geol. Survey Bull. 470, pp. 151–172. 1911.

Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians, with notes on the Dahlonega mines, by Waldemar Lindgren: U. S. Geol. Survey Bull. 293, 134 pp. 1906.

——— Copper: U. S. Geol. Survey Mineral Resources, 1906, pp. 403–404, 1907. 50c.

——— Copper: U. S. Geol. Survey Mineral Resources, 1907, pt. 1, pp. 614–615, 1908.

HAYES, C. W., U. S. Geol. Survey Geol. Atlas, Cleveland folio (No. 20), 1895. 5c.
KEITH, ARTHUR, U. S. Geol. Survey Geol. Atlas, Harper's Ferry folio (No. 10), 1894. Exhausted.
——— U. S. Geol. Survey Geol. Atlas, Knoxville folio (No. 16), 1894. Exhausted.
——— U. S. Geol. Survey Geol. Atlas, Morristown folio (No. 27), 1896. 5c.
——— U. S. Geol. Survey Geol. Atlas, Briceville folio (No. 33), 1896. 5c.
——— U. S. Geol. Survey Geol. Atlas, Maynardville folio (No. 75), 1901. 5c.
——— U. S. Geol. Survey Geol. Atlas, Cranberry folio (No. 90), 1903. 5c.
——— Recent zinc mining in east Tennesee: U. S. Geol. Survey Bull. 225, pp. 208–213, 1904. 35c.
——— U. S. Geol. Survey Geol. Atlas, Nantahala folio (No. 143), 1907. 5c.
——— U. S. Geol. Survey Geol. Atlas, Pisgah folio (No. 147), 1907. 5c.
LA FORGE, L., and PHALEN, W. C., U. S. Geol. Survey Geol. Atlas, Ellijay folio (No. 187), 1913. 25c.
LINDGREN, WALDEMAR, The production of gold in the United States in 1904: U. S. Geol. Survey Bull. 260, pp. 32–38, 1905. 40c.
——— The production of silver in the United States in 1904: U. S. Geol. Survey Bull. 260, pp. 39–44, 1905. 40c.
——— Gold and silver in southern Appalachian States: U. S. Geol. Survey Mineral Resources, 1905, pp. 297–304, 1906. $1.
——— A geological analysis of the silver production of the United States in 1906: U. S. Geol. Survey Bull. 340, pp. 23–25, 1908. 30c.
——— Resources of the United States in gold, silver, copper, lead, and zinc: U. S. Geol. Survey Bull. 394, pp. 114–156, 1909.
MCCASKEY, H. D., Gold, silver, copper, lead, and zinc (mine production) in the Southern Appalachian States: U. S. Geol. Survey Mineral Resources, 1906, pp. 323–332, 1907.
——— Gold, silver, copper, lead, and zinc (mine production) in the Eastern States: U. S. Geol. Survey Mineral Resources, 1907, pt. 1, pp. 551–570, 1908.
——— Notes on some gold deposits of Alabama: U. S. Geol. Survey Bull. 340, pp. 36–52, 1908. 30c.
——— Gold, silver, copper, lead, and zinc (mine production) in the Eastern States: U. S. Geol. Survey Mineral Resources, 1908, pt. 1, pp. 645–682, 1909.
——— Gold, silver, copper, lead, and zinc (mine production) in the Eastern States: U. S. Geol. Survey Mineral Resources, 1909, pt. 1, pp. 533–548, 1910.
——— Gold, silver, copper, lead, and zinc (mine production) in the Eastern States: U. S. Geol. Survey Mineral Resources, 1910, pt. 1, pp. 675–692, 1911.
——— Gold, silver, copper, lead, and zinc (mine production) in the Eastern States: U. S. Geol. Survey Mineral Resources, 1911, pt. 1, pp. 873–888, 1912.
——— Precious and semiprecious metals in the Eastern States (mine production): U. S. Geol. Survey Mineral Resources, 1912, pt. 1, pp. 417–436, 1913.
NITZE, H. B. C., History of gold mining and metallurgy in the Southern States: U. S. Geol. Survey Twentieth Ann. Rept., pt. 6, pp. 111–123, 1899.
PHALEN, W. C., Copper deposits near Luray, Va.: U. S. Geol. Survey Bull. 285, pp. 140–143, 1906. Exhausted.
SANFORD, SAMUEL, and STONE, R. W., Useful minerals of the United States: U. S. Geol. Survey Bull. 585, 250 pp., 1914.
SIEBENTHAL, C. E., Lead: U. S. Geol. Survey Mineral Resources, 1910, pt. 1, pp. 221–259, 1911.
——— Zinc: U. S. Geol. Survey Mineral Resources, 1910, pt. 1, pp. 261–304, 1911.
——— Lead: U. S. Geol. Survey Mineral Resources, 1911, pt. 1, pp. 315–351, 1912.
——— Zinc: U. S. Geol. Survey Mineral Resources, 1911, pt. 1, pp. 353–398, 1912.
——— Lead: U. S. Geol. Survey Mineral Resources, 1912, pt. 1, pp. 335–372, 1913.
——— Zinc: U. S. Geol. Survey Mineral Resources, 1912, pt. 1, pp. 373–416, 1913.
SMITH, G. O., Note on a mineral prospect in Maine: U. S. Geol. Survey Bull. 315, pp. 118–119, 1907.
SMITH, G. O., BASTIN, E. S., and BROWN, C. W., U. S. Geol. Survey Geol. Atlas, Penobscot Bay folio (No. 149), 1907. 5c.
SPENCER, A. C., The Mine Hill and Sterling Hill zinc deposits of Sussex County, N. J.: New Jersey Geol. Survey, Ann. Rept. 1908, pp. 25–52, 1909.
——— SALISBURY, R. D., and KÜMMEL, H. B., U. S. Geol. Survey Geol. Atlas, Franklin Furnace folio (No. 161), 1908. 5c.
STOSE, G. W., The copper deposits of South Mountain in southern Pennsylvania: U. S. Geol. Survey Bull. 430, pp. 122–131, 1910.

WATSON, T. L., Notes on the Seminole copper deposits of Georgia: U. S. Geol. Survey Bull. 225, pp. 182–186, 1904. 35c.
WEED, W. H., Notes on the gold veins near Great Falls, Md.: U. S. Geol. Survey Bull. 260, pp. 128–131, 1905. 40c.
——— Copper deposits of the Appalachian States; U. S. Geol. Survey Bull. 455, 166 pp., 1911.
WILLIAMS, ALBERT, jr., Popular fallacies regarding precious-metal ore deposits: U. S. Geol. Survey Fourth Ann. Rept., pp. 253–271, 1884. $1.65.
WOLFF, J. E., Zinc and manganese deposits of Franklin Furnace, N. J.: U. S. Geol. Survey Bull. 213, pp. 214–217, 1903. 25c.

QUICKSILVER.

By H. D. McCaskey.

INTRODUCTION.

Final figures for the domestic output of quicksilver could be issued by the Survey early in March if all producers and operators would reply more promptly to the first brief requests sent them for complete information. A majority are prompt and the minority delay the figures from two to three months by not answering first requests.

Preliminary figures on the domestic output of quicksilver in 1913 were given out by the United States Geological Survey for publication on January 10, 1914. These data, compiled from earliest information obtainable for the output of the first 11 months and from estimates for December, gave a production for the United States for 1913 of 19,681 flasks of 75 pounds each, valued at $774,054. Of this production 15,396 flasks were credited to California and 4,285 flasks to Arizona, Nevada, and Texas combined.

Complete and revised figures of the United States Geological Survey give a domestic production of quicksilver of 20,213 flasks, valued at $813,171, of which 15,591 flasks were produced in California and 4,622 flasks were produced in Arizona, Nevada, and Texas combined. The total error in the preliminary figures was, therefore, 2.6 per cent, but the error in estimate of the California production was only 1.25 per cent. Whatever credit may be assigned for the close agreement must be given to the producers who courteously gave their early figures and estimates to the Survey.

The present report is a brief statement of the domestic industry in 1913. In the report for 1914, to be published in 1915, a fairly complete treatment of the subject, with a bibliography, is planned for the benefit of visitors to the Panama-Pacific Exposition who may be especially interested in mining.

CONDITION OF THE INDUSTRY.

Owing to generally low prices, the lowest since 1907, the quicksilver industry was even less prosperous in 1913 than in 1912. The market has been very quiet for the last two years, and some large producers are understood to have stored some of their output from time to time and others to have reduced their production until the demand and prices for the metal improve. The world's production in 1911 and 1912 was the largest for many years and probably overran the demand. The output of Italy, Spain, and Austria-Hungary was greater in 1912 and 1911 than for some years previous. Figures of world's production for 1913 show a slight decrease from those of 1912

but nevertheless the output continued large. The domestic production was the lowest, with the exception of that of 1908, since 1860, but it could have been considerably increased if there had been an attractive market. Imports and exports both increased somewhat, but the balance of trade was against the domestic producers. Difficulty in marketing the production has led directly to lowering of prices in the last few years.

A factor reported to have discouraged certain California operators is the legislation for the protection of labor in the mines. The restrictions are said to have made it difficult to operate small mines at a profit. What weight should be attached to this contention is not shown.

Undoubtedly much of the California production is coming from old mines whose richest ores have been removed and which find it difficult to operate at a profit, especially during low prices. In most of these mines special skill is required to prevent them from being operated at a loss; in some of them possibly but little ore remains for extraction. Although each well-developed property is equipped with its own plant and presumably run at lowest cost, the margin of profit is small upon the low-grade ores worked. Possibly further metallurgical improvements may result in a better margin of profit, but the question seems to be whether additional equipment may not cost as much as it will save. In any event but little improvement can be afforded with low market prices and wherever any uncertainty of ore supplies exists. The domestic market appears to demand for consumption around 20,000 flasks per annum. The foreign market is not profitable to American producers in competition with large European supplies that can be produced at lower cost. At low prices and normal output there is little importation, but at high prices importation of foreign quicksilver reacts by cutting into the limited domestic demand. It would seem, therefore, that unless rich ore, workable under most favorable conditions, be available, or industrial chemistry or manufactures find new uses for quicksilver, increasing the demand, the present large producers must continue to operate under rather unfavorable conditions, and new producers and small mines must compete with established mines and plants now presumably operated at lowest cost and with special knowledge and skill.

USES OF QUICKSILVER.

Quicksilver is used mainly in the manufacture of fulminate for explosive caps, of drugs, of electric appliances and scientific apparatus, and in the recovery of precious metals, especially gold, by amalgamation. A new use in Scotland is the floating of lights of lighthouses upon a body of quicksilver. A use in England, in the United States, and possibly elsewhere is the coating of ships' bottoms with a paint containing quicksilver to prevent organic growth. Mercuric oxide (red oxide of mercury) is the active poison in antifouling paint successfully used on ships' bottoms. The metal appears to be but little employed in silvering mirrors, as nitrate of silver is now chiefly used for the purpose. Increasing use of quicksilver is probably to be expected in the manufacture of electrical appliances and of fulminates, and possibly of paints for protective

coatings on metals. The demand for quicksilver for amalgamating gold and silver has greatly decreased, as is well known, with the decreased supply of free milling ores and the increased application of cyanidation to gold and silver ores. Industrial chemistry and inventive genius are to be looked to for increasing the demand.

PRODUCTION.

NUMBER OF MINES, METAL OUTPUT, AND VALUE.

In 1913 there were altogether 24 mines and prospects producing quicksilver in the United States, against 20 in 1912 and 25 in 1911. In all three years also there were a few mines producing ore, but no metal, and a few producing metal from old dumps and furnace material of previous years. Eighteen of the producing mines in 1913 were in California, 3 in Nevada, and 3 in Arizona and Texas combined. As in 1912, 1911, and 1910 no output was reported from Oregon, Utah, or Washington. Arizona produced in a small way in 1913 for the first time in several years.

According to confidential returns to the Survey from every producing district, the output of quicksilver in the United States in 1913 was 20,213 flasks of 75 pounds each, against 25,064 flasks in 1912. At the average domestic price per flask in San Francisco for 1913 of $40.23, the production was valued at $813,171. In 1912 the value was $1,053,941. Compared with the figures for 1912 the yield of 1913 showed a decrease of 4,851 flasks in quantity and of $240,770 in value. The production of California decreased from 20,524 flasks, valued at $863,034, in 1912 to 15,591 flasks, valued at $627,228, in 1913. The output of all other producing States (Nevada and Texas in 1912 and Nevada, Texas, and Arizona in 1913) increased in quantity from 4,540 flasks in 1912 to 4,622 flasks in 1913, but decreased in value from $190,907 in 1912 to $185,943 in 1913.

The following table shows the production for 1911, 1912, and 1913:

Production of quicksilver in the United States, 1911, 1912, and 1913, by States, in flasks of 75 pounds.

State.	1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Arizona					(a)	(a)
California	18,860	$867,749	20,524	$863,034	15,591	$627,228
Nevada	(a)	(a)	(a)	(a)	1,645	66,178
Texas	(a)	(a)	(a)	(a)	(a)	(a)
States not shown separately [b]	2,396	110,240	4,540	190,907	2,977	119,765
Total	21,256	977,989	25,064	1,053,941	20,213	813,171

[a] Included in States not shown separately.
[b] Nevada and Texas combined in 1911 and 1912; Arizona and Texas in 1913.

There is, in addition to production from ore and furnace material (soot and cleanings) given above, an annual output of secondary quicksilver from clean-ups of old gold and silver amalgamation mills and from other sources. This supply tends to reduce the market for new metal somewhat, but probably only to a small degree.

PRODUCTION OF QUICKSILVER, 1902 TO 1913.

The production of quicksilver in the United States for the period 1902 to 1913 is shown in the following table:

Production of quicksilver in the United States from 1902 to 1913, inclusive, in flasks.[a]

Year.	Arizona.	California.	Nevada.	Oregon.	Texas.	Utah.	States not shown separately.	Total.
1902	.....	28,972	.....	.....	5,319	.....	.....	34,291
1903	.....	30,526	65	.....	5,029	14	.....	35,634
1904	.....	29,217	17	.....	5,336	745	.....	35,315
1905	.....	24,635	.....	43	4,723	1,133	.....	30,534
1906	.....	20,310	.....	3	4,761	1,009	.....	26,083
1907	.....	17,431	.....	.....	3,686	437	.....	21,554
1908	(b)	16,984	.....	(b)	2,382	.....	386	19,752
1909	.....	16,078	(b)	(b)	4,188	.....	809	21,075
1910	.....	17,211	70	.....	3,320	.....	.....	20,601
1911	.....	18,860	(b)	.....	(b)	.....	2,396	21,256
1912	.....	20,524	(b)	.....	(b)	.....	4,540	25,064
1913	(b)	15,591	1,645	.....	(b)	.....	2,977	20,213
Total	.....	256,339	c1,797	c 46	c 38,744	3,338	11,108	311,372

a 76½ pounds net for 1902, 1903, and 5 months of 1904; 75 pounds since June 1, 1904.
b Included in States not shown separately.
c Total for years given.

The average total annual output for the period was 25,948 flasks and for California 21,361 flasks. The yields for the United States and for California in 1913 were therefore considerably below the average. For the period California supplied 256,339 flasks, or 82.3 per cent of the total domestic output. Until Texas began producing in 1899, California supplied practically the entire production of the United States for the half century dating back to the earliest recorded output in 1850.

TONNAGE AND RECOVERY.

Producers reported 154,033 short tons of new ore mined and available for treatment in 1913 against 166,564 tons in 1912. Of new and old ore, old furnace material, etc., there were treated 136,278 short tons in 1913, against 155,693 tons in 1912. The average recovery in 1913 was 11.1 pounds of metal per ton treated, or 0.555 per cent of the ore, against 12.1 pounds, or 0.605 per cent, in 1912, and 11.5 pounds, or 0.575 per cent, in 1911.

In California 119,159 short tons were treated in 1913 with an average of 9.8 pounds of metal recovered per ton treated, or of 0.49 per cent of the ore, against a recovery of 11 pounds, or 0.55 per cent, in 1912. In Nevada and Texas combined 16,346 short tons were treated in 1912 with an average recovery of 20.8 pounds per ton, or 1.04 per cent of the ore. In Nevada alone 8,755 tons were treated in 1913 with an average recovery of 14.1 pounds, or 0.71 per cent, and in Arizona and Texas combined in 1913 there were treated 8,464 tons with a recovery of 26.7 pounds per ton, or 1.34 per cent.

The following table gives the tonnage treated and the recovery by States for 1912 and 1913:

Quicksilver ore treated and average recoveries, by States, in 1912 and 1913.

State.	1912			1913		
	Short tons treated.	Pounds of metal recovered per ton.	Percentage of ore recovered as metal.	Short tons treated.	Pounds of metal recovered per ton.	Percentage of ore recovered as metal.
Arizona				(a)	(a)	(a)
California	139,347	11.0	0.55	119,159	9.8	0.49
Nevada	(a)	(a)	(a)	8,755	14.1	.71
Texas	(a)	(a)	(a)	(a)	(a)	(a)
States not shown separately [b]	16,346	20.8	1.04	8,464	26.7	1.34
Total and average for United States.	155,693	12.1	.605	136,278	11.1	.555

[a] Included with States not shown separately.
[b] Nevada and Texas combined for 1912; Arizona and Texas combined for 1913.

During the last few years inquiries have been made by the Survey relative to recoveries by furnaces and retorts, and quantitative data have been published in these reports showing the relatively insignificant total output from retorts, although a considerable number of retort plants are in operation, particularly at prospects and small mines, but also in conjunction with shaft furnaces for treating soot. Quicksilver recovered from soot is credited to furnaces and that credited to retorts is from ore and concentrates treated originally in retorts.

The following table shows the tonnage treated in retorts and in shaft furnaces in 1913 and the recovery of metal from each type:

Quicksilver ore treated in retorts and in furnaces in 1913, by States.

State.	Ore treated, short tons.		Quicksilver recovered, flasks.		Percentage of metal recovered per ton of ore treated.	
	Retorts.	Furnaces.	Retorts.	Furnaces.	Retorts.	Furnaces.
California	618	118,541	336	15,255	2.04	0.48
Nevada	800	7,955	425	1,220	1.99	.58
Other States [a]	9	8,355	15	2,962	6.25	1.33
Total United States	1,427	134,851	776	19,437	2.04	.54

[a] Includes Arizona and Texas.

In previous reports the writer has given brief notes on the metallurgy of quicksilver and references to the literature on quicksilver reduction. A few copies of those reports remain for free distribution.

DEPOSITS, ORES, AND GANGUES.

For detailed descriptions of domestic quicksilver deposits the reader should consult the considerable literature, including former quicksilver reports, references to which are given in preceding Survey reports on this subject. In the report for 1911 the writer gave a summary and generalization on deposits, ores, and gangues, mainly

for the benefit of those not needing great details, or of miners, prospectors, or others to whom the literature is not generally accessible. Prospectors have apparently found the information useful. A few copies of that report are still available for free distribution by the Survey. A more complete treatment of the subject will follow further field work and will probably be published in a future report of this series.

RESOURCES, OCCURRENCES, AND DEVELOPMENTS, BY STATES.

ARIZONA.

There was no production of quicksilver in Arizona in 1911 or 1912, but in 1913 a small output was reported from both Maricopa and Yuma counties.

Maricopa County.—In the Mazatzal Mountains, on the northeastern boundary between Maricopa and Gila counties, there has been considerable activity in prospecting for quicksilver since the close of 1912. The ore is cinnabar associated with quartz and contained in green (chlorite?) schists. The locality has taken the name of the Sunflower district from the Sunflower ranch, about 8 miles south, on Sycamore Creek, and the district extends over the Mazatzal Range into Gila County on the east, although the principal locations are on the west side of the range, in Maricopa County, near the headwaters of Sycamore Creek, and include Pine Mountain. The west fork of the Sycamore, Alder Creek, heads to the west of a spur of the Mazatzal Mountains, but prospecting in this region has not yet disclosed the presence of cinnabar, according to reports. A number of claims were located by Messrs. Bowman, Murphy, and others, and the Sunflower Cinnabar Mining Co., of Phoenix, took over some of these and did considerable development work. The Maricopa Quicksilver Co. controls claims about 1 mile northeast of the Sunflower properties. The Sunflower properties produced a few flasks of quicksilver in 1913 from ore treated in retorts. A Scott furnace was planned for this company, but has not yet been erected. There has been some change in organization of the operators and work was suspended at last reports. The other claims in the district have not yet produced quicksilver, but are under development.

Yuma County.—The Cinnabar Development Co., operating claims in the Quartzite district of Yuma County, referred to in previous reports of the Survey, produced a small quantity of quicksilver, partly from ore on the dumps mined in previous years. The property is equipped with a 30-ton Scott furnace and a 3-ton Johnson-McKay retort plant. The plant was shut down in June, 1913.

CALIFORNIA.

The quicksilver industry was generally quiet in California in 1913. The few larger producers maintained the greater part of the output; but prospecting and development continued at many properties, some of which are reported to show considerable supplies of ore.

The production of quicksilver in California in 1913 was 15,591 flasks, valued at $627,228, a decrease from the output of 1912 of

4,933 flasks in quantity and of $235,806 in value. It was the smallest production in quantity and in value since 1860. In 1913 California furnished 77.1 per cent of total domestic production, against 81.9 per cent in 1912, 88.7 per cent in 1911, 83.5 per cent in 1910, and 76 per cent in 1909.

The following table shows the quicksilver output of California from earliest recorded production in 1850 to date, giving the best available data for quantity of flasks produced and average San Francisco domestic price per flask. The flask was 76½ pounds of quicksilver until June, 1904, and has been of 75 pounds net since.

Quicksilver production of California, 1850–1913, in flasks.

Year.	Flasks.	Price per flask.	Value.	Year.	Flasks.	Price per flask.	Value.
1850	7,723	$99.45	$768,052	1883	46,725	$28.75	$1,343,344
1851	27,779	66.93	1,859,248	1884	31,913	30.50	973,347
1852	20,000	58.33	1,166,600	1885	32,073	30.75	986,245
1853	22,284	55.45	1,235,648	1886	29,981	35.50	1,064,325
1854	30,004	55.45	1,663,722	1887	33,760	42.375	1,430,580
1855	33,000	53.55	1,767,150	1888	33,250	42.50	1,370,625
1856	30,000	51.65	1,549,500	1889	26,464	45.00	1,190,880
1857	28,204	48.73	1,374,381	1890	22,926	52.50	1,203,615
1858	31,000	47.83	1,482,730	1891	22,904	45.25	1,036,406
1859	13,000	63.13	820,690	1892	27,993	40.71	1,139,595
1860	10,000	53.55	535,500	1893	30,164	36.75	1,108,527
1861	35,000	42.05	1,471,750	1894	30,416	30.70	933,771
1862	42,000	36.35	1,526,700	1895	36,067	37.04	1,335,922
1863	40,531	42.08	1,705,544	1896	30,765	34.96	1,075,544
1864	47,489	45.90	2,179,745	1897	26,691	37.28	995,040
1865	53,000	45.90	2,432,700	1898	31,092	38.23	1,188,647
1866	46,550	53.13	2,473,202	1899	29,454	47.70	1,404,956
1867	47,000	45.90	2,157,300	1900	26,317	44.94	1,182,686
1868	47,728	45.90	2,190,715	1901	26,720	48.46	1,294,851
1869	33,811	45.90	1,551,925	1902	28,972	43.20	1,251,590
1870	30,077	57.38	1,725,818	1903	30,526	45.29	1,382,523
1871	31,686	63.10	1,999,387	1904	29,217	43.50	1,270,940
1872	31,621	65.93	2,084,773	1905	24,635	36.22	892,280
1873	27,642	80.33	2,220,482	1906	20,310	39.50	802,245
1874	27,756	105.18	2,919,376	1907	17,431	39.60	690,268
1875	50,250	84.15	4,228,538	1908	16,984	44.17	750,183
1876	72,716	44.00	3,199,504	1909	16,078	45.45	730,745
1877	79,395	37.30	2,961,434	1910	17,211	46.51	800,484
1878	63,880	32.90	2,101,652	1911	18,860	46.01	867,749
1879	73,684	29.85	2,199,467	1912	20,524	42.05	863,034
1880	59,926	31.00	1,857,706	1913	15,591	40.23	627,228
1881	60,851	29.83	1,815,185				
1882	53,732	28.23	1,488,624	Total	2,140,333		95,902,923

The total value of the quicksilver production of California from earliest output to date may be taken at $95,902,923. The highest annual value in this period of 64 years was $4,228,538 in 1875, when the output was 50,250 flasks of 76½ pounds each, and the average annual price was $84.15 a flask; and the lowest value was $535,500 in 1860, when the output was estimated at 10,000 flasks, and the average price was $53.55. The highest number of flasks produced in any one year was 79,395, in 1877, and the lowest was 7,723, in 1850. The highest price was $105.18 in 1874, and the lowest was $28.23 in 1882. For the period of 64 years the average annual value was $1,498,483, the average annual output was 33,443 flasks, and the average yearly price was $44.81 per flask—whether the flasks were of 76½ pounds or of 75 pounds each.

The output of quicksilver in California in 1913, as compared with that in 1912, increased in Fresno, Lake, San Luis Obispo, and Santa

Barbara counties, and decreased in Napa, San Benito, Santa Clara, Sonoma, and Trinity counties. No production was reported from Colusa, Kings, Monterey, Siskiyou, Solano, Stanislaus, and Yolo counties in either 1913 or 1912.

As usual, the county leading in output was San Benito, which contains the New Idria mines, the most important producers in recent years in the Western Hemisphere. The next county in rank was Santa Clara, in which are the New Almaden mines, credited with the greatest total output of the country to date, and the Guadalupe, the second largest producer in California. Third in rank was San Luis Obispo County, which displaced Sonoma County, which in 1912 in turn displaced Lake County, in this respect.

There were 18 producing quicksilver mines in California in 1913. The total ore mined was 123,464 short tons, against 138,198 tons in 1912. The ore treated in California in 1913 was 119,159 short tons, against 139,347 tons in 1912. Of the ore treated in 1913 the retorts received 618 short tons, producing 336 flasks of metal, and the shaft furnaces 118,541 tons, producing 15,255 flasks.

The production of quicksilver in California in 1911, 1912, and 1913 is shown by counties in the following table:

Production of quicksilver in California, by counties, during 1911, 1912, and 1913, in flasks of 75 pounds.

County.	1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Fresno and Lake [a]	829	$38,143	436	$18,334	694	$27,920
Napa	267	12,285	286	12,026	260	10,460
San Benito	9,809	451,312	9,754	410,156	9,718	390,956
San Luis Obispo	244	11,226	609	25,608	1,241	49,926
Santa Clara	7,533	346,593	8,695	365,625	3,562	143,299
Other counties [b]	178	8,189	744	31,285	116	4,667
Total	18,860	867,748	20,524	863,034	15,591	627,228

[a] No production in Fresno County in 1911.
[b] Colusa, Santa Barbara, Sonoma, and Trinity combined in 1911; Santa Barbara, Sonoma, and Trinity combined in 1912 and 1913.

Colusa County.—The Manzanita mine in Colusa County remained idle in 1913 and may not be reopened, according to reports. At this mine interesting experiments in concentrating quicksilver ores had been made by the owner,[1] and the principles of concentration have since been experimented with at the Wall Street mine in Lake County and the Ætna and Oat Hill mines in Napa County.[2]

Fresno County.—The Little Panoche (old Mercy) mine, near South Dos Palos, in Fresno County, was developed in 1913 and considerable construction work was done. The production increased and the outlook was reported promising for further increase. The plant includes a 25-ton Scott furnace and two 300-pound D retorts.

Kings County.—The Summit property, near Parkfield, in Kings County, was developed in 1913, and it was reported that a 10-ton Scott furnace would be completed for operation by 1914. Assessment work only was done on the Segregation and other claims.

[1] Northey, G. V., Concentration of cinnabar ores: Eng. and Min. Jour., Oct. 25, 1913, p. 783.
[2] Eddy, L. H., Quicksilver operations in northern California: Eng. and Min. Jour., Nov. 1, 1913.

Lake County.—The production of quicksilver in Lake County in 1913 was from the Helen and Wall Street mines and somewhat increased over the output of 1912. Brief descriptions of these mines and their plants were given by the writer in the Survey report for 1912.[1] The Mirabel, Chicago, Bear Canyon, Great Western, Utopia, and other properties in this county were all idle in 1913. The Helen mine is equipped with a 50-ton Scott furnace and the Wall Street mine with a small concentrating plant for soft ores, built by the owner, and a D retort plant.

Monterey County.—At the Parkfield property, in Monterey County, some tunnels were driven by contract in search of ore in 1913, but according to reports the outlook did not warrant continuation of the work.

Napa County.—The production of quicksilver in Napa County in 1913 was 260 flasks, valued at $10,460, against an output of 286 flasks, valued at $12,026, in 1912. The Ætna mines were the principal producers, but small output was also made from the Knoxville and Oat Hill mines.

At the Ætna mines both ore mined in 1913 and old dumps were concentrated before treatment in D retorts. The experimental concentrating mill has treated material running as high as 3 per cent in quicksilver, but the flow sheet was not fully determined upon in 1913, when the equipment included a Griffin mill, 2 Gilpin County bumping tables, and 3 New Standard concentrators.

The Knoxville mine is equipped with a 30-ton Livermore furnace and a D retort, with a capacity of 600 pounds per charge.

At the old Oat Hill mine experiments in concentrating old dumps were made in 1913 with incidental production of metal from concentrates treated in a pipe retort with a capacity of 250 pounds per charge. Flumes, with cross riffles, grizzly, and screens, and cross-wash concentrators, are used, and the recovery in concentrates is reported so satisfactory that a large plant will be put up to treat the accumulated waste dumps from many years of mining. Half of these dumps are believed to be capable of profitable concentration.

These interesting experiments in Napa County in concentrating low-grade material, following the successful work for many years along similar lines at the Manzanita mine, in Colusa County, are suggestive of the possibilities of future production of quicksilver by treating concentrates from the vast tonnages of old mine dumps, especially in California. The well-known marked difference in specific gravity between cinnabar and the common gangue minerals, and the familiar use of the miner's pan and horn spoon in prospecting for quicksilver ores, suggest the ready separation of cinnabar from gangue, especially in the soft ores and old dumps. Thorough water sorting will probably prove essential to complete success, and both power and water must be available in sufficient quantity and at low cost.

San Benito County.—The production of quicksilver in San Benito County in 1913 was 9,718 flasks, valued at $390,956, against 9,754 flasks, valued at $410,156, in 1912. The output was almost wholly from the New Idria mines, as usual, but small production was also reported from the Hernandez and the Esmeralda properties.

[1] McCaskey, H. D., Quicksilver: U. S. Geol. Survey Mineral Resources, 1912, pt. 1, pp. 940–941, 1913.

At the Alpine properties development work was impeded by heavy flows of water and of explosive gases, but progress was made looking to production. At the Florence Mac only assessment work was done in 1913. At the Tiger prospecting was continued, and at the Hernandez a small production was made from a pipe retort. At the Aurora (Esmeralda) construction work continued on a new patented rotary furnace to be completed in June, 1914, and a small recovery was made of metal from the ruins of an old Fitzgerald furnace on the property that was torn down to supply brick for the new furnace and condensers.

The New Idria mine continued to be the most important quicksilver producer in America. The mine was visited and briefly described by the writer in the Survey report for 1908.[1] The property is equipped with 3 Scott furnaces, 1 for fine and 2 for coarse ores, with a capacity of 80 tons each per day. General development work continued, including the driving of the tunnel to the San Carlos ore body, which was expected to be completed early in 1914.

San Luis Obispo County.—The production of quicksilver in San Luis Obispo County in 1913 was 1,241 flasks, valued at $49,926, against 609 flasks, valued at $25,608, in 1912. The output was almost entirely from the Oceanic mine, but the Capitola and the Little Bonanza prospects contributed also.

At the Oceanic mine a large tonnage of excellent furnace ore is reported available for extraction, and there was a greatly increased output both of ore from the mine and of metal from the 50-ton Scott furnace and the D retorts used for treating furnace soot. Active development on the easterly extension of the vein, and the sinking of a new shaft below the main adit to explore the ground below the old workings were reported for 1913.

The Cambria mine was idle. At the Doty prospect development work is reported to have disclosed ore, but it awaits extraction for lack of a furnace for treatment. The Klau mine made no production in 1913 and at the Josephine only a small amount of development work was done. The Little Bonanza made a small output from pipe retorts. The Capitola, equipped with one large D retort, also made a small production in 1913. At the Cypress Mountain and Rinconada properties no production was reported, although development work is said to be promising at the latter.

Santa Barbara County.—In Santa Barbara County a small production was made from 12 pipe retorts on the Acachuma claim, and development work was done on the Davis & Castillo property in 1913. Production was also reported from pipe retorts at the Los Prietos mine, where promising ore has been developed.

Santa Clara County.—The quicksilver production of Santa Clara County was 3,562 flasks, valued at $143,299, in 1913, against an output of 8,695 flasks, valued at $365,625, in 1912.

The prospect of Arnerich & Dunker, reported to be on a continuation of the mineralized belt extending through the Guadalupe and New Almaden properties, was developed by W. J. Bennett in 1913. At the New Guadalupe a large tonnage of ore was again mined and treated, resulting in important output, but operations were curtailed

[1] McCaskey, H. D., Quicksilver: U. S. Geol. Survey Mineral Resources, 1908, pt. 1, pp. 686–689, 1909.

pending a rise in the price of quicksilver. The plant includes 2 fine-ore 14-ton furnaces and 2 coarse-ore 24-ton furnaces, using oil as fuel, and furnace heat is used to dry ore before charging into the furnace. The plant has been practically rebuilt under the efficient direction of the present general manager. The famous old Almaden mine, with the largest total production to date of all domestic quicksilver producers, was operated under new management in 1913 and continued production from reworking of old mine dumps and also from ore from the El Senador prospect, near the Guadalupe property. Leases were given and ore for the furnaces was paid for on a sliding scale to the lessees. The equipment includes a Scott tile and shaft furnace plant with a total capacity of 154 tons per 24 hours. This plant was the origin of the Scott modification of the Hüttner furnace, now generally used in quicksilver production at all the larger mines in the United States.

Siskiyou and Solano counties.—There was no production reported from either Siskiyou or Solano counties in 1913. At the St. John mine in Solano County a small amount of development work was done, but the mine was practically shut down.

Sonoma County.—A nominal output only was made from the Cloverdale mine in Sonoma County in 1913, and operations were reported curtailed owing to the low price of quicksilver. Some development work was done and considerable quantities of ore are reported available. The plant includes a 15-ton incline furnace and one D retort. The Culver-Baer, Pacific, Great Eastern, Napa, Socrates, and other properties were also reported idle in 1913. At the Great Eastern, however, experiments were reported looking toward the concentration of low-grade ore.

Stanislaus County.—At the Newhall property, in Stanislaus County, development work was reported promising in 1913. The Mount Boardman property adjoins the Newhall.

Trinity County.—A nominal output only was reported from final clean-up of the furnace of the Altoona mine in Trinity County in 1913.

IDAHO.

There was no production of quicksilver or operation of quicksilver properties reported from Idaho in either 1913 or 1912. The occurrences of cinnabar in the State were described in the Survey report for 1911.

NEVADA.

The quicksilver production from Nevada in 1913 was 1,645 flasks, valued at $66,178. Figures for the output in 1911 and 1912 were combined with those of Texas in the reports for those years to conceal individual production. There were three properties reported productive in Nevada in 1913, the Ruby in Humboldt County, and the Mercury and Telluride in Nye County.

The occurrences of quicksilver ore in Nevada and references to the literature were given in considerable detail in the Survey report for 1911.

Humboldt County.—The Ruby quicksilver mine in Eldorado Canyon, on the west side of the Humboldt Range near Humboldt House, Humboldt County, was actively operated in 1913, and a considerable output of quicksilver was made from the battery of 12-pipe retorts

with a total capacity of 5 tons in 24 hours. A 30-ton furnace is planned for this mine. At the Gold Banks property, in the Gold Banks district, about 35 miles south of Winnemucca, on the west side of the Sonoma Range, there was no production in 1913, but considerable activity was reported in preparation for construction of a furnace to treat the large quantities of ore said to be available there. A 10-pipe retort plant has already been completed at the Gold Banks. The Nevada-Almaden and Dixie quicksilver properties in American Canyon, on the east side of Humboldt Range, opposite Rochester, did not produce in 1913. Several other cinnabar prospects have been under development in the Humboldt Range south of Rochester, and the Dolbear property, especially, in the Antelope Springs district, 15 or 20 miles south of Rochester, has been under active development. Considerable supplies of good ore are reported available here that can be cheaply mined by open cuts. A 12-pipe retort, with exhausting condenser and original features for supplying currents of fresh air to the bed of roasting ore, has been erected, and has been in successful operation since the close of 1913.

Mineral County.—In the Pilot Mountains, and about 13 miles east of Mina, Mineral County, the finding of the "lost Hawthorne quicksilver mine," by Tom Pepper and Charles Keough, cattlemen, while hunting lost steers, was reported in June, 1913, and a rush of miners to the vicinity resulted in the location of a large number of claims. Some of these are reported to be promising and to show large quantities of surface ore, and development work has been done on a few of them; but the greater number of the claims were not developed to the close of 1913. The ore, in part at least, is reported to be in blue limestone and associated with barite and to carry gold, silver, and lead in addition to quicksilver in the form of cinnabar. Other surface showings of cinnabar are reported to be in disintegrated granite.

Nye County.—The quicksilver deposits of the old Ione district, on the west side of the Shoshone Mountains, in Nye County, were briefly described by the writer in the quicksilver report for 1911.[1] At the Mercury mine a considerable quantity of ore was again mined and treated in the 25-ton Scott furnace. Development work, covering 1,800 feet of drifting, crosscutting, raising, and sinking, was reported for 1913. At the Shoshone mines of the newly organized Nevada Cinnabar Co., development work was done and a 50-ton Scott furnace, of the Mirabel type, was completed for operation in 1914. At the Fahy-Nelson prospect, southwest of Austin, on the east side of the Shoshone Range, development work was reported to have shown considerable supplies of commercial ore. In Rough Canyon, 2 miles north of the Fahy-Nelson property, the occurrence of large quantities of cinnabar-bearing material of a grade too low for profitable extraction was reported and development work was abandoned.

In the Fluorine district, on Bare Mountain, east of Beatty, the Telluride group produced ore treated in the 12-ton furnace of the Telluride Consolidated Corporation, which leased these and developed other claims. New discoveries of ore on Bare Mountain are reported, and the outlook is said to be promising for increased pro-

[1] McCaskey, H. D., Quicksilver: U. S. Geol. Survey Mineral Resources, 1911, pt. 1, pp. 908–909, 1912.

duction. The Trapmann prospect, near Rhyolite, and the Mercury and Bond prospects, near Beatty, were reported under development.

OREGON.

There have been no operations of quicksilver properties reported from Oregon in 1913 or 1912. The occurrences of quicksilver ore and references to the literature were given in some detail in the Survey report for 1911.

TEXAS.

Figures for the output of quicksilver in Texas in 1913, 1912, and 1911 have been combined with those of other States to conceal individual production.

The following table shows the quicksilver production of Texas from the beginning of operations in 1899 to the end of 1910:

Production of quicksilver in Texas, 1899–1910, in flasks.[1]

1899	1,000	1906	4,761
1900	1,800	1907	3,686
1901	2,932	1908	2,382
1902	5,319	1909	4,188
1903	5,029	1910	3,320
1904	5,336		
1905	4,723	Total	44,476

Brewster County.—The quicksilver deposits of the Terlingua region of Brewster County, which have supplied the entire output of this metal from the State, have been briefly described in the Survey reports for 1907 and 1910, and lists of references to the literature have been given.[2]

The only operations in the Terlingua region since 1910 have been at the Chisos mine, which continued active development and output. This property has been supporting for several years an important settlement of American operators and Mexican laborers in the Big Bend country, and has been managed under the personal direction of the owner who has maintained law and order and has given the region all the facilities of civilization possible during turpulent times on the Mexican border. The mine is developed by several shafts, three of which are now through the Eagle Ford shale and in the Buda or "Vola" limestone, which overlies the Del Rio clay, at the base of which, and in the limestone immediately below, were found the rich ore bodies of the Marfa-Mariposa mine west of the great fault. One shaft has penetrated the Buda limestone 100 feet without reaching the Del Rio clay. Some ore is being found in minute fissures in this limestone, and ore was found along lines of displacement of the sunken block of the Chisos ground. A tongue of igneous rock extending from the South into Eagle Ford shale has been cut in the underground workings and near this intrusive ore was also found.

In Block G–4 in the Terlingua district some prospecting has led to plans for operations in 1914.

[1] Flasks, 76½ pounds net; 75 pounds since June 1, 1904.

[2] McCaskey, H. D., Quicksilver: U. S. Geol. Survey Mineral Resources, 1907, pt. 1, pp. 680–682, 1908. Also, U. S. Geol. Mineral Resources, 1910, pt. 1, pp. 702–703, 1911.

UTAH, WASHINGTON, AND ALASKA.

There have been no production or operations at quicksilver properties in Utah, Washington, or Alaska in 1913. The occurrences and references to the literature were summarized in the Survey report for 1911.

At the Leavenworth prospect, in Chelan County, Wash., there was some activity in 1912 but only assessment work was done in 1913. A new occurrence of quicksilver in Washington was reported in the the Eclipse lode, in the Stilaguamish district of Snohomish County.

WORLD'S PRODUCTION.

The following table gives the estimated world's production of quicksilver, in metric tons of 2,204.6 pounds, for the years 1903–1912. For foreign countries the quantities are from the corrected figures of the Nineteenth Annual Issue of Comparative Statistics, compiled by the Metallgesellschaft, Metallurgischen Gesellschaft A. G., and the Berg- und Metallbank Aktiengesellschaft, of Frankfort on the Main, Germany; for the United States the figures are those of the United States Geological Survey. Foreign figures for the output of 1913 are from advance statistics of the Metallgesellschaft, kindly furnished by the American Metal Co.

World's production of quicksilver, 1904–1913, in metric tons.

Country.	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
United States	1,235	1,038	888	734	672	717	701	723	853	688
Austria-Hungary	550	570	577	567	630	609	694	793	733	855
Italy	357	369	418	423	680	771	894	931	986	988
Russia	332	318	210	130	49	7	4	.....	.....	.....
Spain	1,130	853	1,567	1,212	1,068	1,393	1,114	[a] 1,486	[a] 1,490	[a] 1,490
Mexico and others	[b] 190	[b] 190	[b] 200	[b] 200	[b] 200	[b] 150	[b] 150	[b] 150	[b] 150	[b] 150
Total	3,794	3,338	3,860	3,266	3,299	3,647	3,557	4,083	4,262	4,171

[a] Exports from Spain in 1911–1913. [b] Estimated.

A considerable increase is noted for the world's total output for 1910 and 1911 following the increase of price in 1910. The production of Spain, Italy, and Austro-Hungary was mainly responsible, although the output of the United States increased also in 1911. As the European output is reported to be controlled by the Rothschild interests, the London market is practically the dominant factor and distributing point.

IMPORTS AND EXPORTS.[1]

The import tariff on quicksilver from 1890 to 1895 was 10 cents per pound; from 1895 to 1913 it was 7 cents; and the Underwood Tariff Bill, enacted late in 1913, made the tariff 10 per cent ad valorem, which, for the whole year 1913 was roughly equivalent to 3.9 cents per pound.

[1] For statistics of imports and exports acknowledgment is made to the Bureau of Foreign and Domestic Commerce, Department of Commerce.

The imports have been almost wholly into the port of New York and chiefly from Spain by way of England, but also from Italy and Austria, and showed some increase for 1913, as indicated in the accompanying table. The exports showed a smaller increase than the imports and went to the countries shown in the following tables:

Quicksilver imported and entered for consumption in the United States, 1905–1913, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1905	2,690	$1,710	1910	667	$381
1906	81	50	1911	471,944	251,386
1907	16,567	6,719	1912	82,706	39,920
1908	15,113	8,216	1913	[a] 171,653	75,361
1909	15,968	8,203			

[a] Of this quantity 97,976 pounds came from England (presumably Spanish), 42,565 pounds came from Germany (origin not known), 22,500 pounds came from Italy, and 8,000 pounds came from Austria, or 171,041 pounds in all, received in New York in 1913.

Exports of quicksilver from the United States, 1905–1913, in flasks of 75 pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Year.
1905	13,534	$489,756	1910	1,923	$91,077
1906	6,456	243,914	1911	291	13,995
1907	5,132	192,094	1912	310	13,360
1908	2,996	124,960	1913	1,140	43,574
1909	6,802	266,243			

Exports of domestic quicksilver from the United States, 1911–1913, by countries, in pounds.

Country.	1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Europe:						
England					215	$140
North America:						
Canada	9,585	$6,318	6,413	$3,598	80,162	40,362
Newfoundland	75	48				
Mexico	5,285	3,262	3,130	1,816	1,500	821
Central America:						
Costa Rica	2,550	1,594	4,150	2,447	306	165
Guatemala			900	505		
Honduras	229	143	409	287	75	43
Nicaragua	1,436	905	355	251	750	483
Panama			95	64	103	74
Salvador	300	181	300	160	675	368
Outlying Islands:						
Cuba			75	43		
Dutch West Indies			25	18		
Dominican Republic	95	63	280	170	89	41
South America:						
Bolivia					92	53
Brazil	54	36				
Colombia	1,662	1,088	1,030	562	1,090	738
Ecuador	45	36				
Venezuela	75	45	4,546	2,539	89	67
Asia:						
Chosen (Korea)			1,575	900		
Hongkong					150	84
Philippines	450	276			225	135
Total	21,841	13,995	23,283	13,360	85,521	43,574

PRICES.

Prices of quicksilver have materially declined in each of the last two years and the decline has seriously affected the prosperity of the industry. In the table following the prices for New York and London are given as taken from the Engineering and Mining Journal. As the primary domestic market is in San Francisco, the price there for 1913 is averaged from weekly and monthly quotations as published in the Mining and Scientific Press. The prices received by producers in individual sales varied, of course, from the market prices as published, which are annual averages of generally prevailing quotations.

Average yearly prices of quicksilver in the United States and London from 1907 to 1913, inclusive.[a]

[Per flask of 75 pounds.]

Year.	San Francisco (domestic).	New York.	London.
1907	$39.60	$41.50	.....
1908	44.17	44.84	.....
1909	45.45	46.30	.....
1910	46.51	47.06	.....
1911	46.01	46.54	.....
1912	42.05	42.46	£8.14
1913	[b] 40.23	39.54	7.38

[a] From Eng. and Min. Jour., New York. [b] From Min. and Sci. Press, San Francisco.

LITERATURE.

Fairly complete lists of references to the literature on quicksilver for the North American continent have been given at intervals in previous Survey reports, and a new and complete list is in preparation for the report for 1914.

GOLD, SILVER, AND COPPER IN ALASKA IN 1913.

(MINES REPORT.)

By Alfred H. Brooks.

INTRODUCTION.[1]

Measured by value of output, the Alaska mining industry was less prosperous in 1913 than in 1912. Extensive developments were continued, however, during the year in some of the gold lode districts, notably at Juneau, and to a less extent at Willow Creek and Fairbanks. This activity, consisting chiefly of underground dead work and of the installation of mills, has not yet contributed in any large measure to the gold production, and therefore two-thirds of Alaska's gold output still comes from the placer mines. Less than 40 per cent of the placer gold is produced by large plants, the remainder being still won from the rich gravels that can be profitably mined by hand methods. Under such conditions no stability of placer gold production is to be expected. Every four or five years there are unusually dry seasons which may almost entirely curtail operations except dredging. Such conditions prevailed in 1913 in the Yukon districts, in the Iditarod-Innoko region, and on Seward Peninsula. These conditions, together with the approaching exhaustion of the bonanza deposits of the Fairbanks district, account for the decrease in gold output. It must not be concluded from this statement that there is any shortage of auriferous gravels, but only of those that can be mined under the present high operating cost. New areas of placer ground that could be profitably exploited by dredges, if transportation charges were reduced, are constantly being discovered. Moreover, the installation of dredges in the more accessible parts of the Seward Peninsula has continued, as in previous years.

The finding during 1913 of deposits of auriferous gravels in two new and widely separated localities, namely, in the upper Matanuska basin and in the upper basin of the Chisana (locally called Shushana), a tributary of the Tanana, furnishes new fields for the prospector. These discoveries curtailed the gold output in some of the larger camps, because they drew away many miners, and thus caused a shortage of labor.

[1] Aid has been rendered in the preparation of this report by E. M. Aten, who has assisted in the collection of statistics from mines. The data on mining development here presented are all taken from United States Geological Survey Bulletin 592, which deals with the region in a more detailed way.

What is true of the cost of mining placer deposits applies also to lode mining except on tidewater. The Fairbanks district has shown what can be accomplished in lode mining under the most adverse conditions of transportation, labor, water, and fuel. The coastal region is developing at a rate which bids fair to overshadow all mining operations in the interior, and no marked progress can be expected in the inland region until a transportation system is provided.

The falling off in copper output is less significant, because it is due solely to the fact that the Kennecott-Bonanza, much the largest copper producer, was closed, on account of accidents, for about one-third of the year.

In the Seward Peninsula there was, in some places, not even water enough to float the dredges. There were 36 gold dredges operated in Alaska in 1913, as compared with 38 in 1912. Of these, 31 were in Seward Peninsula; 2 in the Iditarod district; and 1 each in Fairbanks, Circle, and Twentymile districts. Besides the operated dredges a number of others were in course of construction.

As in previous years, attempt has been made to base statistics of production, as far as possible, on statements of individual producers, the only reliable source of information. Though the cordial cooperation of most of the important mine operators has been secured, there are still a few large producers of placer gold and many smaller ones who neglect to reply to the Survey request for information. In connection with this work the writer is under special obligations, for valuable information, to the Director of the United States Mint, to the collectors of the customs service, to the many United States commissioners in the Territory, to officials of banks and of transportation companies, and to prominent residents. All these data have been carefully sifted, and the accompanying figures are based upon them.

The limit of error of the statement of the total gold production of the Territory is believed to be within 2 per cent. In the crediting of the proper amounts to individual districts, however, the error may be in some cases as high as 8 per cent.

PRODUCTION.

The production of gold, silver, and copper in Alaska for 1912 and 1913 are shown in the following table:[1]

Mine production of gold, silver, and copper in Alaska, 1912-13.

Year.	Gold.		Silver.		Copper.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ozs.		*Fine ozs.*		*Pounds.*		
1912	829,435	$17,145,951	515,186	$316,839	29,230,491	$4,823,031	$22,285,821
1913	755,947	15,626,813	362,563	218,988	21,659,958	3,357,293	19,203,094
Decrease, 1913	73,488	1,519,138	152,623	97,851	7,570,533	1,465,738	3,082,727

[1] According to C. E. Siebenthal, the smelter reports showed a return of 45 tons of lead from Alaska ores in 1912, valued at $4,050, and of 6 tons in 1913, valued at $528.

The following table is an estimate of the total production of gold, silver, and copper in Alaska since the beginning of auriferous mining in 1880. For the early years the figures are probably far from being correct, but they are based on the best information now available.

Production of gold, silver, and copper in Alaska, 1880-1913.

Year.	Gold.		Silver.		Copper.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.	Quantity (pounds).	Value.
1880	967	$20,000				
1881	1,935	40,000				
1882	7,256	150,000				
1883	14,561	301,000	10,320	$11,146	3,933	$826
1884	9,723	201,000				
1885	14,512	300,000				
1886	21,575	446,000				
1887	32,653	675,000				
1888	41,119	850,000	2,320	2,181		
1889	43,538	900,000	8,000	7,490		
1890	36,862	762,000	7,500	6,071		
1891	43,538	900,000	8,000	7,920		
1892	52,245	1,080,000	8,000	7,000		
1893	50,213	1,038,000	8,400	6,570		
1894	62,017	1,282,000	22,261	14,257		
1895	112,642	2,328,500	67,200	44,222		
1896	138,401	2,861,000	145,300	99,087		
1897	118,011	2,439,500	116,400	70,741		
1898	121,760	2,517,000	92,400	54,575		
1899	270,997	5,602,000	140,100	84,276		
1900	395,030	8,166,000	73,300	45,494		
1901	335,369	6,932,700	47,900	28,598	250,000	40,000
1902	400,709	8,283,400	92,000	48,590	360,000	41,400
1903	420,069	8,683,600	143,600	77,843	1,200,000	156,000
1904	443,115	9,160,000	198,700	114,934	2,043,586	275,676
1905	756,101	15,630,000	132,174	80,165	4,805,236	749,617
1906	1,066,030	22,036,794	203,500	136,345	5,871,811	1,133,260
1907	936,044	19,349,743	149,784	98,857	6,308,786	1,261,757
1908	933,290	19,292,818	135,672	71,906	4,585,362	605,267
1909	987,417	20,411,716	147,950	76,934	4,124,705	536,211
1910	780,131	16,126,749	157,850	85,239	4,241,689	538,695
1911	815,276	16,853,256	460,231	243,922	27,267,878	3,403,485
1912	829,435	17,145,951	515,186	316,839	29,230,491	4,823,031
1913	755,947	15,626,813	362,563	218,988	21,659,958	3,357,293
Total	11,048,488	228,392,540	3,456,611	2,060,190	111,953,435	16,927,518

The value of the gold produced in Alaska in 1913 is estimated at $15,626,813, and that of silver at $218,988, the number of ounces of gold at 755,947, and of silver at 362,563. In 1912 the output of gold was valued at $17,145,951. The copper output of Alaska for 1913 was 21,659,958 pounds, valued at $3,357,293, a decrease from 1912 of 7,570,533 pounds. Comparison is made in the following table between the gold production of 1912 and of 1913 by regions.

Value of production of gold in Alaska, 1912 and 1913, by regions.

Region.	1912	1913	Increase +, decrease −
Pacific coast belt, including southeastern Alaska and Prince William Sound	$4,904,753	$4,529,529	− $375,224
Copper River and Cook Inlet region	358,401	378,643	+ 20,242
Yukon and Kuskokwim basins	8,857,797	8,183,641	− 674,156
Seward Peninsula and northwestern Alaska	3,025,000	2,535,000	− 490,000
Total	17,145,951	15,626,813	−1,519,138

Value of gold production of Alaska, with approximate distribution, 1880-1913, by regions.

Year.	Pacific coast belt.	Copper River and Cook Inlet region.	Yukon basin.	Seward Peninsula and northwest Alaska.	Total.
1880	$20,000				$20,000
1881	40,000				40,000
1882	150,000				150,000
1883	300,000		$1,000		301,000
1884	200,000		1,000		201,000
1885	275,000		25,000		300,000
1886	416,000		30,000		446,000
1887	645,000		30,000		675,000
1888	815,000		35,000		850,000
1889	860,000		40,000		900,000
1890	712,000		50,000		762,000
1891	800,000		100,000		900,000
1892	970,000		110,000		1,080,000
1893	838,000		200,000		1,038,000
1894	882,000		400,000		1,282,000
1895	1,569,500	$50,000	709,000		2,328,500
1896	1,941,000	120,000	800,000		2,861,000
1897	1,799,500	175,000	450,000	$15,000	2,439,500
1898	1,892,000	150,000	400,000	75,000	2,517,000
1899	2,152,000	150,000	500,000	2,800,000	5,602,000
1900	2,606,000	160,000	650,000	4,750,000	8,166,000
1901	2,072,000	180,000	550,000	4,130,700	6,932,700
1902	2,546,600	375,000	800,000	4,561,800	8,283,400
1903	2,843,000	375,000	1,000,000	4,465,600	8,683,600
1904	3,195,400	500,000	1,300,000	4,164,600	9,160,000
1905	3,430,000	500,000	6,900,000	4,800,000	15,630,000
1906	3,454,794	332,000	10,750,000	7,500,000	22,036,794
1907	2,891,743	275,000	9,183,000	7,000,000	19,349,743
1908	3,448,318	401,500	10,323,000	5,120,000	19,292,818
1909	4,264,716	265,000	[a] 11,580,000	4,302,000	20,411,716
1910	4,182,730	351,630	[a] 8,062,389	3,530,000	16,126,749
1911	4,265,573	313,538	[a] 9,139,145	3,135,000	16,853,256
1912	4,904,753	358,401	[a] 8,857,797	3,025,000	17,145,951
1913	4,529,529	378,643	[a] 8,183,641	2,535,000	15,626,813
Total	65,912,156	5,410,712	91,159,972	65,909,700	228,392,540

[a] Includes a small production from the Kuskokwim basin.

In 1913 about 31.6 per cent of the total gold production came from lode mines, compared with 29 per cent of total gold output credited to lode mines in 1912; in 1911 it was 24 per cent of total. This indicates a gradual transition from placer mining to lode mining. A decrease in placer mining must be expected until railroads have so reduced the cost of operation as to make the less valuable auriferous gravels available to profitable exploitation.

In the following table the production of precious metals has been distributed as to sources:

Sources of gold, silver, and copper in Alaska, 1913, by kinds of ore.

	Ore.	Gold.		Silver.		Copper.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ozs.*		*Fine ozs.*		*Pounds.*	
Siliceous ores	1,614,506	232,916.58	$4,814,813	30,897	$18,662		
Copper ores	135,756	6,385.50	132,000	273,179	165,000	21,659,958	$3,357,293
Placers		516,645.00	10,680,000	58,487	35,326		
Total	1,750,262	755,947.08	15,626,813	362,563	218,988	21,659,958	3,357,293

The total gold production from the auriferous lode mines of Alaska which have been productive since 1882 is estimated to be 3,029,538 fine ounces, valued at $62,626,113. These mines have also produced 1,096,336 fine ounces of silver, with a commercial value of $667,516. It is estimated that since mining began in 1880 Alaska gold placers have yielded 8,005,136 fine ounces of gold, valued at $165,480,848. These mines have also produced 1,710,503 fine ounces of silver, having a commercial value of $996,069. The total production of copper from the Alaska mines up to close of 1913 was 111,953,435 pounds, valued at $16,927,518. Most of this copper has been produced since 1901, when systematic mining of this ore began.

Some of the Alaska gold ores carry considerable galena, and from this source some lead has been recovered. The total Alaska lead output since 1892, when the galena ores were first systematically mined, is estimated to be about 800 short tons, valued at $57,000.

Alaska's auriferous lodes are estimated to have produced during the year 232,916 fine ounces of gold, valued at $4,814,813, as compared with an output of 241,991 fine ounces, valued at $5,002,399, in 1912. Thirty gold lode mines, including several properties in the new lode districts which made only small outputs, were operated the whole or a part of the year in 1913 in Alaska—6 more than in 1912. Work was also done on many gold prospects. Of the producing mines 14 were in Fairbanks district, 7 in southeastern Alaska, 3 in Willow Creek district, 2 at Valdez, 2 in Kenai Peninsula, and 2 in southwestern Alaska. It is estimated that these mines had an output of 1,614,506 tons of ore, as compared with 1,761,814 tons, the total output for 1912. In 1912 the average value of gold-silver contents for all the ores mined was $2.85 a ton; the average for 1913 was $2.99.

There were 7 productive copper mines in 1913, as compared with 8 in 1912. Of these, 3 were in the Ketchikan district, 3 on Prince William Sound, and 1 in the Kotsina-Chitina district. The total copper production in 1913 was 21,659,958 pounds, valued at $3,357,293, compared with 29,230,491 pounds, valued at $4,823,031, in 1912. About $132,000 in gold and $165,000 in silver was recovered from the copper ores. It is estimated that in 1913 about 135,736 short tons of copper ore were hoisted, as compared with 93,452 tons in 1912. The average copper content of the ore was about 7.97 per cent, and the gold-silver values about $2.18 to the ton. The large average copper percentage is due to the very high grade ores shipped from the Kennecott-Bonanza mine.

The value of the placer-gold production in 1913 is estimated at $10,680,000; that of 1912 was $11,990,000. It is estimated that a total of about 700 placer mines were operated in 1913 compared with 720 in 1912. About 150 mines were operated during the winter and 650 in summer. A rough estimate indicates that in 1913 about 6,800,000 cubic yards of gravel were excavated, with an average recovery per cubic yard of $1.57, as against 7,050,000 cubic yards excavated in 1912, with an average recovery of about $1.70 per cubic yard. Thirty-six gold dredges operated in 1913, handled 4,100,000 cubic yards of material, and recovered gold to the value of about $2,200,000. In 1912 the gold dredges operated numbered 38, with an estimated recovery of the same amount of gold as in 1913. This was due to the fact that on account of low water in 1913 more of the dredges than in 1912 were operated only a part of the season.

REVIEW BY REGIONS.

PACIFIC COAST BELT.

SOUTHEASTERN ALASKA.

There were 7 lode gold mines, about 4 placer gold mines, and 3 copper mines operated on a productive basis in southeastern Alaska during 1913. Far more important was the extensive development of lode mines in the Juneau district, and, to a less extent, in the Berners Bay region. The operating mines produced 201,360 ounces of gold, valued at $4,229,648; 29,211 ounces of silver, valued at $17,643; and 599,903 pounds of copper, valued at $92,985. A total of about 1,589,746 tons of gold ore and 7,276 tons of copper ore was hoisted in 1913.

Juneau district.—The extensive mining developments continued at Juneau during the year bid fair to make it the center of one of the largest gold-producing districts on the continent. In 1913 only the four mines of the Treadwell group were operated on a productive basis, although a very large amount of development work was done on several other properties.

The driving of the adit tunnel of the Alaska-Gastineau Co. was vigorously pushed throughout the year. Work was also continued on No. 1 shaft of the old Perseverance mine. These two workings were connected in April, 1914, thus giving an outlet, on the one hand, to the surface at the Perseverance mine, and on the other to the beach at the Sheep Creek portal. The adit is 8 by 10 feet and 10,500 feet long. Meanwhile there has been much development work on the fifth to the tenth levels, inclusive, of the Perseverance mine, and mill construction and other surface improvements are well under way. One power plant on Salmon Creek for this enterprise is completed, and work on a second was continued during the year, as weather conditions permitted.

The Snowslide Gulch adit of the Alaska-Juneau mine, 6,538 feet in length, was completed. A raise was then started, which reached the surface in March, 1914. A working level was also started. A tram was built from the portal to the mill site near Juneau, where the first unit of a large reduction plant is approaching completion and other surface improvements have been made. The company states that it plans later to put in a main adit tunnel from the mill site, near Juneau, which will be 9,000 feet long and 400 feet lower than the present tunnel. Power is to be furnished from a hydroelectric plant on Nugget Creek.

Plans are under way to open the Ebner property, lying adjacent to the Alaska-Juneau on the north. Some work was done on other gold lode properties, but details in regard to these are lacking.

Work was continued on the new adit tunnel of the Eagle River mine, located 800 feet below the old workings. This has been driven 1,900 feet and is reported to have intersected the ore body. Some developments were also made on the Peterson and the Auk Bay properties. The driving of the adit of the Kensington mine in the Berners Bay region was continued. Two lodes, the Eureka and the Kensington, had been crosscut by the adit, and in 1913 the adit was extended toward the Johnson lode, and this lode is said to have been crosscut 4,800 feet from portal at depth of 800 feet. Some

drifting on the lode was also done. It is reported that work was continued at the Jualin mine, consisting of the sinking of a shaft and surface improvements. Information is lacking at this writing regarding any other mining developments in the Berners Bay region.

Ketchikan district.—Three copper mines were operated on a productive basis in the Ketchikan district during the year. Work was continued at the Rush & Brown mine throughout the year. The first and second levels were extended and a winze was sunk to third level. A new boiler and hoist were installed. The Jumbo mine was also operated throughout the year. New workings consisted of adits driven and a winze sunk from the lower level. At the Big Harbor mine some 50 feet of drifts and stopes were excavated in 1913, and some shipments of copper ore were made. The small stamp mills at the Valparaiso and Harris River gold mines were operated in 1913, and some developments made on the Londevan and the Bugge properties.

Porcupine district.—Hydraulic plants were operated on Porcupine, Calhoun, and Nugget creeks in 1913. Another plant was installed on Glacier Creek, and preparations were made for putting in a dredge on the lower part of Nugget Creek. Developments were continued in a small way on some quartz properties in this district.

Sitka district.—The two 10-stamp mills of the Chichagof mine,[1] in the Sitka district, were operated throughout the year. A new hydroelectric power plant and an air compressor are being installed and underground developments were continued. At the Hirst property, also in Sitka district, the vein is reported to have been crosscut at the upper level, and another crosscut started 165 feet below this and 350 feet below the surface. About 1,250 feet of underground work has been done on this property.

YAKATAGA DISTRICT.

Mining was continued on the beach placers near Yakataga on about the same scale as in previous years. A large hydraulic plant was installed on White River.

PRINCE WILLIAM SOUND.

The value of the total mineral production of the Prince William Sound region in 1913 was $1,327,950, as compared with $1,250,000 in 1912. The Ellamar and Beatson copper mines of the Prince William Sound region were operated to full capacity in 1913, and shipments were also made from the properties of the Fidalgo Mining Co. The Dickey Copper Co. opened the Mason & Gleason claim on Fidalgo Bay and mined some ore which will be sledded to the beach during the winter. Developments were continued by the Three Man Mining Co. and the Land Lock Bay Copper Co. Work was suspended during the summer at the Midas copper mine, near Valdez, but was resumed by a new company, which purchased the property in the fall.

The Cliff mine in the Port Valdez district was operated throughout the year, and small mills were erected at the Gold King, Cameron & Johnson, Mountain King, and Minnie properties. In addition to the

[1] Formerly operated as two mines—the Chichagof and the Golden Gate.

operations at the mines enumerated, work was done on about 25 other claims. There was considerable development of auriferous quartz veins in the Port Wells district, and it is estimated that some work was done on about 100 different claims.

KENAI PENINSULA.

In the aggregate, there was considerable gold lode prospecting in the Kenai Peninsula, but no important developments. Placer mining was continued on about the same scale as in previous years. The value of the total gold production of the peninsula for 1913 was less than $50,000.

At the Kenai-Alaska Gold Co.'s mine about 400 feet of crosscuts were driven and 150 feet of drifts along fissures. The aerial tram broken last year was repaired and the mill was run for a short time. Work was continued at the Skeen-Lechner mine. A 4-stamp mill was completed in September, 1913, and operated the last part of the year by use of hydroelectric power. An aerial tram connects the mine with the mill. There was also much underground work, amounting at the close of the year to some 1,000 feet in length. On the property of the Primrose Mining Co. a 150-foot crosscut was driven and a 30-foot raise. A small prospecting mill was used for testing the ore, and a larger mill has been planned.

Late in the summer the Gold Stamp Mining Co. installed a 2-battery mill of 5 stamps near its claim on Bear Creek. Waterpower is to be employed for this plant.

Development work was continued on the Gilpatrick lode in the Moose Pass district. Some ore from this claim was treated in an arrastre. The Moose Pass Mining Co. continued operations in a small way on its claim, located near the head of Quartz Creek, and installed a small prospecting mill during the summer.

About 15 placer mines were operated for a whole or a part of the open season of 1913. Operations were more or less hampered on some creeks by a scarcity of water. Most of these operations were on a very small scale, but hydraulic plants were operated on Resurrection, Bear, and Crow creeks. The testing of dredging ground on Kenai River and elsewhere was continued.

SOUTHWESTERN ALASKA.

Kodiak Island.—The Aniak Gold Mining Co., whose property is near Uyak, on Kodiak Island, continued work. It is reported that 115 feet of shaft were sunk in 1913. The stamp mill was operated to test the ore. There was also some mining of beach placer gold on Kodiak Island, as well as prospecting of gold lode deposits.

Iliamna region.—With the exception of the recovery of a few hundred dollars' worth of gold from the gravels of Portage Creek, a tributary of Lake Clark, there was no productive mining in the Iliamna region. There was, however, considerable prospecting and development of copper and gold-bearing lodes in this region.

Alaska Peninsula.—So far as known, there was but little mining development on the Alaska Peninsula in 1913. No report has been received from the Apollo mine, but it is rumored that the mill was run for a short time and that there was some underground work.

COPPER RIVER REGION.

Kotsina-Chitina district.—There was no great activity in the Kotsina-Chitina copper belt during 1913. With the present high freight rates on copper ore and in the absence of any spurs or branch lines of railways, operators found little encouragement to push development work. There was, moreover, a shortage of labor, due to the exodus to the Chisana placer district. The Kennecott-Bonanza continues to be the only productive mine, and its operation was hampered by the destruction of tramway and compressor plant by a snowslide and fire. As a consequence, shipments were only made for about eight months during the year. Work was also continued on the nearby Jumbo claims belonging to the same company. Some small shipments of ore were made from this property, and an aerial tram was surveyed. Some development work was done on the Dan Creek and other copper properties located in the eastern end of the Kotsina-Chitina belt.

The Mother Lode mine is on the McCarthy Creek side of the Bonanza divide. Here the underground workings were extended during 1913, and a 6,600-foot aerial tram connecting the mine with a proposed wagon road following down McCarthy Creek valley was built. The wagon road has not been completed, but meanwhile some ore was sledded to the railroad, a distance of about 13 miles. An air compressor, driven by a gasoline engine, is being installed. A gold quartz vein, located near McCarthy and belonging to the Bonanza Gold Mining Co., is reported by the owners to have been developed on a small scale. It is also stated that a small prospecting mill was installed.

There was comparatively little mining at the western end of the field. Developments are reported on the Hubbard & Elliot property, on Nugget Creek and on the Berg claim, the latter located on the east side of Kuskulina River. Some work was also done by the Great Northern Development Co., which shipped some ore from its property during the winter of 1912–13.

Nizina and Bremner districts.—In the Nizina placer district two large hydraulic plants were operated throughout the year and a third after it had been rebuilt. In September, 1912, the hydraulic plant of the Dan Creek Mining Co. was almost totally destroyed by an unusually severe flood. In 1913 the plant was reconstructed. The Nizina Mining Co.'s plant on Chititu Creek was damaged by the same flood, but not so severely as the plant on Dan Creek. During the early summer the damaged section was reconstructed, and productive mining was carried on for the remainder of the season. The Nizina Mining Co. also operated a hydraulic plant on Rex Creek throughout the summer. Five or six men were engaged in mining on Chititu and tributaries independent of the Nizina Mining Co. The Budd Mining Co. commenced the installation of a hydraulic plant on Gold Creek in Bremner district, where it is proposed to work gold placer deposits in the basin above the lower falls.

Chistochina district.—From 30 to 40 men were engaged in productive mining on 9 or 10 properties in the Chistochina placer district. A small hydraulic plant was installed, and some ground was prospected with the purpose of the installation of a dredge.

SUSITNA AND MATANUSKA BASINS.

Albert Creek placers.—During the summer of 1913 considerable local excitement was caused by the discovery of auriferous gravels in the region adjacent to the upper Matanuska basin. As a consequence, 75 to 100 prospectors were attracted to this region. Placer gold was found on Albert Creek, a branch of Crooked Creek, tributary to Nelchina River, one of the forks of the Tazlina.

Willow Creek district.—Mining in the Willow Creek lode district continued on about the same scale as in 1912. Three mills—the Gold Bullion, the Alaska Free Gold, and the Gold Quartz—were in more or less continuous operation, and about 70 men were employed in mining and milling. About 3,000 tons of ore were milled, with a gold recovery to the value of $100,000. Several promising discoveries of quartz veins were made during the year, and plans were under way to install mills at three additional localities in 1914.

Yentna district.—Placer mining in the Yentna district was continued in 1913 on about the same scale as during the last few years. No important new discoveries were made, and the production was all from creeks, the value of which had already been proved.

Valdez Creek district.—The most important development during the year on Valdez Creek, a tributary of the upper Susitna, was the installation of a large hydraulic plant for the recovery of gold in a buried channel. This plant was completed before the close of the summer and some sluicing was done. There were also some smaller operations on Valdez Creek and its tributaries.

YUKON BASIN.

The dry weather and other conditions already discussed gave the Yukon districts very unfavorable conditions for placer mining. The value of the placer-gold production is estimated to have been about $7,780,000 in 1913, compared with $8,645,000 in 1912. The newly discovered Chisana placer-gold district in the upper Tanana was encouraging to the prospector, but it caused a movement of miners that resulted in a shortage of labor in several camps. On the other hand, the progress in lode mining at Fairbanks was a very hopeful feature of the year's history.

Chisana district.—In May, 1913, William E. James and Peter Nelson found gold placers on a small stream called by them Little Eldorado, which flows into Bonanza Creek, tributary to Chatenda Creek, an easterly fork of upper Chisana River. During the summer mining was done on the discovery and on some other claims in the neighborhood. The value of the total output from the district is variously estimated between $40,000 and $70,000. Gold has also been found on several tributaries of Chapolda Creek, which lies across the divide north of Johnson Creek and flows westward into the Chisana. This district is a part of the Nabesna-White River region, where some copper prospects are being developed.

Fairbanks district.—During 1913 quartz mining made steady progress in the Fairbanks district. There were 14 lode properties from which more or less production was made, of which 10 were equipped with mills. Gold to the value of $350,000 was produced from the quartz mines of the district in 1913, against $200,000 in 1912.

About 130 placer mines were operated in the Fairbanks district for a whole or a part of the year. The value of the placer-gold production was about $3,300,000. The chief creeks, arranged in order of the value of their production, give the following sequence: Chatanika Flats and Cleary, Ester and tributaries, Goldstream and Engineer, Dome, Pedro, Fairbanks, and Little Eldorado. Gold was also mined on Vault, Treasure, Wildcat, Fish, and Happy creeks. Some new discoveries were made on Alder, Smallwood, and Happy creeks, and the productive area in the Chatanika Flats, at the mouths of Dome and Cleary creeks, was enlarged. New mines were also developed on Fairbanks and Dome creeks.

Smaller Yukon districts.—Twenty mines, including two hydraulic plants, were worked for a whole or a part of the season in the Birch Creek district. One dredge was operated on Mastodon Creek. Mastodon, Eagle, and Half Dollar creeks were the principal producers in this district.

In the Fortymile district the shortage of water greatly hampered mining operations. About 25 mines were worked in the winter and 15 in the summer. One dredge was operated on South Fork of Fortymile. Operations were continued on about the same scale as in the pass in the Eagle, Seventymile, Rampart, Kantishna, Tenderfoot, and Bonnifield districts. The Hot Springs district continues to be one of the large producers of gold in the Yukon region. This gold was chiefly taken from Sullivan, Patterson, and American creeks.

All told, there were 41 plants engaged in actual mining in the Ruby district, operating 38 claims on 14 different creeks. The most significant new development in the district was the discovery of valuable placer ground on several creeks in an area about 30 miles south of the Long Creek locality. The chief discoveries are on Poorman Creek, tributary to the North Fork of Innoko River, and on Duncan and Tenderfoot creeks, tributary to Poorman from the north. Placers have also been found on Tamarack, a tributary of Solatna, that heads against Duncan.

The owners report that work was continued on the Little Squaw quartz property, in the Chandalar district. On the Carter property, in the same district, a crosscut has been driven for 400 feet and is said to have intersected the ore 200 feet below the surface. A little placer mining was done on two claims in the Chandalar district.

Reports from the Koyukuk are very meager, as but few of the mine operators see fit to return the schedules mailed to them by the Survey each year.

From best reports, between 300 and 400 men were engaged in placer mining in the Koyukuk in 1913, and the season was a profitable one, although there was some shortage of water, as in the other Yukon camps. The most important developments were those on Hammond River, where some deep rich gravels were developed. A little mining was done in the Indian River district of the Middle Koyukuk basin. Here 13 claims were worked in a small way.

Iditarod district.—As in the other Yukon camps, the shortage of water greatly hampered mining operations. This condition, together with the fact that certain claims were not worked because they were being combined into large holdings for the purpose of exploiting in a large way, led to great curtailment of gold output compared with

1912. The value of the gold production from the Iditarod district was $1,860,000. There was some prospecting of lode claims and some promising deposits have been found, but the cost of mining is so great that few mines have been attracted to quartz development.

The dredge installed on Flat Creek in 1912 was worked throughout the open season. A second large dredge was built on Flat Creek in 1913, and was also operated.

The largest gold production in the Iditarod district came from the mines on Otter and Flat creeks, but mining was also done on Happy, Willow, Moore, Chicken, and Black creeks, and on Glenn Gulch. Most of the mining is by open cuts, steam scrapers being extensively used.

Innoko district.—Shortage of water curtailed the Innoko gold output in 1913, estimated to have a value of $280,000, of which about $80,000 was mined in the winter. Sixteen claims were worked in the winter, employing about 50 men, and 28 claims in summer.

The most important developments were on Little Creek, where a considerable area of rich placer was found. The productive creeks, in order of the value of their production, were Little, Ophir, Spruce, Colorado, Fox, Ganes, and Yankee. Some claims on Yankee Creek have been combined for the purpose of mining by dredge. Dredging ground was also prospected on Ganes Creek, with reported favorable results. There was some extensive prospecting of Candle Creek, which flows into the Tokotna, a tributary of the Kuskokwim.

KUSKOKWIM BASIN.

There are many creeks in the lower half of Kuskokwim basin, on which there has been some mining, but about which there is very little information. In 1913 a hydraulic plant was in course of installation on Marvel Creek in the Anniak basin. There has been some mining on Marvel, Cripple, and other creeks of the Anniak district.

Across the divide is Bear Creek, a tributary of the Tuluksak, and here mining has gone on for several years. In 1913 considerable ground was prospected on Bear Creek with a drill, and preparations were made for the installation of a steam scraper. Mining has also been done on Bonanza, a tributary of Bear Creek.

Elk River flows into the Kuskokwim from the east about 50 miles below Bethel. In 1913 placer gold was found in the headwater region of the Elk, indicating that the region between the Tuluksak and Goodnews Bay districts is also mineralized. About 12 men were engaged in mining and prospecting in the Goodnews Bay region.

SEWARD PENINSULA.

The drought which prevailed all over northern Alaska was specially pronounced in Seward Peninsula. So low were the streams that even some of the dredges could not operate, and for others it was necessary to make artificial basins by cutting into the bedrock or by building dams. As a result the gold recovery of 1913 in the Seward Peninsula camps was only $2,500,000, compared with $3,100,000 in 1912.

Thirty-one dredges were operated for a part or the whole of the summer, with an estimated gold recovery valued at $1,330,000. These dredges had a combined daily capacity of 33,300 cubic yards. Four new dredges were installed in 1913 and several others were in course of construction. The building of several others is under contemplation. In addition to 31 operated, 6 dredges were idle in 1913. Of other than dredge mining there was very little. Some deep mining was done during the winter near Nome and in the Fairhaven district. In some instances there was not water enough to sluice the winter dumps. A little hydraulic mining was done in several districts when the water supply permitted. The dry season also hampered the small operators throughout the peninsula. There was some development of auriferous lodes in Seward Peninsula, but no production.

KOBUK REGION.

The placer mines of the Kobuk region produced about $40,000 in gold in 1913. Most of this came from Klery Creek, in the Squirrel River district, but there was little mining on Lynx and Dahl creeks and on Shungnak River. Some work was also done on gold and copper lodes.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN COLORADO IN 1913.[1]

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

GENERAL STATEMENT.

The total value of the production of gold, silver, copper, lead, and zinc in Colorado in 1913, as reported from 858 mines, of which 29 were placers, amounted to $35,450,585, as compared with $37,320,966 in 1912, a decrease of $1,870,381. Of the total value, 51 per cent represented gold, which was valued at $18,146,916, a decrease of $441,646, as compared with the yield of 1912. There was an increase in silver output of 1,113,185 fine ounces. The production of copper, which is mainly incidental to the recovery of other metals, increased 120,523 pounds. The quantity of lead produced in 1913 was 87,897,773 pounds, an increase of 12,655,506 pounds. The quantity of zinc produced was 119,346,429 pounds, a decrease of 12,876,383 pounds.

ORE PRODUCTION IN 1913.

The output of ore sold or treated in 1913 from Colorado mines was 2,734,866 short tons, an increase of 158,240 tons, as compared with the production of 1912.

The output of siliceous and dry ores was 2,161,458 tons, an increase of 195,158 tons. The output of copper ores was 16,555 tons, an increase of 2,837 tons; the production of lead ores was 205,774 tons, an increase of 23,029 tons; and the output of zinc ores decreased 36,651 tons, from 177,946 tons in 1912 to 141,295 tons in 1913. There were 6,417 tons of copper-lead ores produced in 1913, a decrease of 393 tons. The output of lead-zinc ores was 203,367 tons, a decrease of 25,740 tons. The combined output of zinc and lead-zinc ores showed a decrease of 62,391 tons.

During 1913 there were treated at amalgamating and cyaniding mills, including also a very small quantity at chlorinating mills, with or without concentration equipment (including all the custom mills in the State), 1,610,335 tons of ore having an average recovery as bullion or precipitates of 0.344 ounce gold and 0.28 ounce silver per ton.

[1] For discussion of the geology of the districts mentioned in the following pages the reader is directed to the bibliography appended to the report for 1912, in Mineral Resources, 1912, pt. 1, pp. 704–705, 1913, and to U. S. Geol. Survey Bull. 507: The mining districts of the western United States, by J. M. Hill, with a geological introduction by Waldemar Lindgren, 1912.

From the 1,610,335 tons treated at amalgamating, cyaniding, and chlorinating mills, and from 459,533 tons sent to concentration and separation mills, a total to both classes of mills of 2,069,868 tons (76 per cent of the total tonnage treated, as compared with 76 per cent in 1912), were produced 218,291 tons of concentrates—ratio 9.5 to 1—with an average total value of $39.94 per ton, as compared with $44.24 per ton in 1912.

Ore milled in 1913, in terms of metals recovered as bullion or by concentration, averaged 0.328 ounce gold and 1.34 ounces silver per ton, 0.06 per cent copper, and 1.14 per cent lead.

Crude ore shipped to all kinds of smelters amounted to 664,998 tons, averaging 0.271 ounce gold and 9.86 ounces silver per ton, 0.37 per cent copper, and 3.07 per cent lead.

Crude ore and concentrates shipped to all kinds of smelters therefore amounted to 883,289 tons, averaging 0.343 ounce gold and 10.05 ounces silver per ton, 0.41 per cent copper, and 4.98 per cent lead.

In 1913 there were 29 productive placers in Colorado which yielded $408,540 in gold and 4,563 fine ounces, valued at $2,756, in silver, a total of $411,296 in gold and silver, as compared with $427,025 in 1912, with $321,704 in 1911, with $398,140 in 1910, with $461,508 in 1909, and with $186,058 in 1908.

The statement of Colorado production from 1904 to 1913, showing increase or decrease of 1913 over 1912, and total value at each year's commercial price, is as follows:

Production of gold, silver, copper, lead, and zinc in Colorado, 1904–1913.[a]

Year.	Number of producing mines.	Tonnage.	Gold.[b]	Silver.[b]	Copper.	Lead.	Zinc.	Total value.	Average total value per ton.
		Short tons		*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	578	2,333,881	$24,463,322	13,947,635	9,435,962	102,792,782	101,016,774	$43,175,775	$17.89
1905	513	2,504,087	25,023,973	11,499,307	9,404,830	111,585,060	83,150,445	43,587,081	17.37
1906	664	2,648,923	23,210,629	12,216,830	5,720,929	104,102,269	86,965,308	43,738,757	16.51
1907	642	2,383,128	20,826,194	11,229,776	7,724,590	85,406,849	52,788,326	37,423,838	15.67
1908	667	2,243,891	22,300,627	8,905,433	9,997,738	52,200,130	30,130,002	31,948,722	14.16
1909	925	2,219,741	21,989,336	8,902,633	10,922,046	72,167,790	51,210,260	33,907,140	15.07
1910	898	2,434,664	20,507,058	8,509,598	8,359,535	76,071,273	77,089,648	33,673,879	13.67
1911	861	2,377,936	19,001,975	7,330,168	8,024,488	69,679,289	94,607,456	32,418,218	13.08
1912	856	2,576,626	18,588,562	8,212,070	7,107,303	75,242,267	132,222,812	37,320,966	14.32
1913	858	2,734,866	18,146,916	9,325,255	7,227,826	87,897,773	119,346,429	35,450,585	12.81
Increase (+) or decrease (−)	+2	+158,240	−441,646	+1,113,185	+120,523	+12,655,506	−12,876,383	−1,870,381	−1.51

[a] United States Geological Survey figures, as calculated from reports from the mines.
[b] Includes placer production.

GOLD.

The total gold production for Colorado in 1913 was 877,857.06 fine ounces, valued at $18,146,916, as against 899,221.69 fine ounces, valued at $18,588,562, in 1912, a decrease of 21,364.63 fine ounces in quantity and of $441,646 in value.

The Cripple Creek district, with a decrease of $103,359, produced $10,905,003 in gold, which was 60 per cent of the Colorado gold output from all sources.

The San Juan region in Dolores, La Plata, Ouray, San Juan, and San Miguel counties, showed a decrease of $43,662. There was an increase of $177,500 in La Plata, of $134,038 in San Juan, and of $4,876 in Dolores, but a decrease of $269,863 in San Miguel and of $90,213 in Ouray County. Other counties showing an increased output of gold were Chaffee and Summit, but notable decreases were made in Boulder, Gilpin, Gunnison, Lake, Mineral, and Park.

Siliceous and dry ores, which made 97 per cent of all the tonnage mined, yielded 817,065.17 fine ounces, valued at $16,890.236, or 93 per cent of all the gold production. A little more than 3 per cent came from lead ores, less than 1 per cent from copper ores, a negligible per cent from copper-lead ores, and less than 1 per cent from zinc and lead-zinc ores. A little more than 2 per cent came from placers.

The output of placer gold in 1913 was 19,763.12 fine ounces, valued at $408,540, a decrease of $15,345. Summit County, with 3 dredges and 4 placers, produced nearly 95 per cent of the placer yield. The greater part of the remainder came from sluicing operations in Park, Moffat, and Chaffee counties. There were small placer yields in Costilla, Douglas, Gilpin, Gunnison, Montrose, and Rio Grande counties.

Source of gold production in Colorado in 1913, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	
Boulder		3,127.96	62.58	160.06		0.53		3,351.13
Chaffee	61.25	5,520.17	19.35	9,531.88			3.50	15,136.15
Clear Creek		18,047.84	144.25	2,437.79		214.73	77.05	20,921.66
Costilla	4.59							4.59
Custer		710.19	.12	.03				710.34
Dolores		329.28	143.90	97.84		1.85	28.53	601.40
Douglas	26.46							26.46
Eagle		1,532.57	172.99	17.55			270.91	1,994.02
Fremont			4.45					4.45
Garfield		43.05						43.05
Gilpin	23.32	28,774.75	4,205.29	235.15				33,238.51
Gunnison	29.07	449.52		8.84		4.02	1.44	492.89
Hinsdale		48.93	25.73	160.91			19.85	255.42
Lake		37,903.51	2,545.36	7,252.35	73.92	429.68	1,313.33	49,518.15
La Plata		15,135.95	.15					15,136.10
Mineral		712.00		688.84			1,031.55	2,432.39
Moffat	172.21							172.21
Montrose	45.23		.24					45.47
Ouray		46,132.11	226.10	19.72		2.00	29.93	46,409.86
Park	713.92	517.57	50.87	1,104.76		.51	33.10	2,420.73
Pitkin		1.02		.38				1.40
Rio Grande	2.47		9.29					11.76
Routt	2.37	11.08		.10				13.55
Saguache		31.01	1.60	146.67		13.21	12.77	205.26
San Juan		25,651.11	3.65	3,398.27		1,043.46	1,715.49	31,811.98
San Miguel		102,953.20		55.12				103,008.32
Summit	18,682.23	1,902.85		1,529.62			245.59	22,360.29
Teller		527,529.52						527,529.52
Total, 1913	19,763.12	817,065.19	7,615.92	26,845.88	73.92	1,709.99	4,783.04	877,857.06
Total, 1912	20,505.44	841,295.84	8,759.86	19,766.81	532.51	1,936.59	6,424.64	899,221.69
Increase (+) or decrease (−)	−742.32	−24,230.65	−1,143.94	+7,079.07	−458.59	−226.60	−1,641.60	−21,364.63

SILVER.

The silver yield in Colorado in 1913 was 9,325,255 fine ounces, valued at $5,632,454, as against 8,212,070 fine ounces, valued at $5,050,423 in 1912, an increase of 1,113,185 fine ounces in quantity and of $582,031 in value.

Lake County showed for 1913 an increase of 399,921 ounces and the output was 36.5 per cent of the State yield, as compared with 37 per cent in 1912. Notable increases in output were made in Boulder, Chaffee, Clear Creek, Dolores, Eagle, Gunnison, Lake, La Plata, Mineral, Park, Pitkin, and San Juan counties, and notable decreases in Gilpin and San Miguel counties.

In the production of silver, 9 counties, ranking in the order named, Lake, San Miguel, San Juan, Mineral, Pitkin, Ouray, Clear Creek, Eagle, and Gilpin, furnished 88 per cent of the total.

Siliceous and dry ores yielded 6,270,758 fine ounces, or 67 per cent of the silver output; lead ores, 1,645,186 ounces, or nearly 18 per cent; lead-zinc ores, 668,632 ounces, or more than 7 per cent; copper-lead ores, 491,058 ounces, or over 5 per cent. A negligible percentage came from zinc ores and from placers.

Source of silver production in Colorado in 1913, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	
Boulder		90,552	968	63,848		7,016		162,384
Chaffee	15	49,337	3,117	115,845			671	168,985
Clear Creek		262,165	3,748	134,837		1,413	6,364	408,527
Costilla	2							2
Custer		10,240	139	934				11,313
Dolores		29,867	42,028	43,795		2,482	60,644	178,816
Douglas	2							2
Eagle		220,322	3,018	51,347			26,693	301,380
Fremont			63				15	78
Garfield		35						35
Gilpin	3	255,634	13,581	3,989				273,207
Gunnison	8	47,054	104	35,509		1,871	2,942	87,488
Hinsdale		11,141	6,966	10,240			2,130	30,477
Lake		2,498,297	139,514	318,009	21,950	1,333	421,215	3,400,318
La Plata		118,414	2,708					121,122
Mineral		715,919		20,705			68,719	805,343
Moffat	8							8
Montrose	7		427					434
Ouray		493,422	4,182	35,464		2,669	1,897	537,634
Park	139	77,558	326	12,453		3,328	489	94,293
Pitkin		130,482		431,826				562,308
Rio Grande			109					109
Routt		1,919		35				1,954
Saguache		37	9	7,792		441	415	8,694
San Juan		165,929	2,101	203,078		470,505	38,796	880,409
San Miguel		998,958		52,138				1,051,096
Summit	4,379	22,127		103,342			37,642	167,490
Teller		71,349						71,349
Total, 1913	4,563	6,270,758	223,108	1,645,186	21,950	491,058	668,632	9,325,255
Total, 1912	5,106	5,397,439	224,327	1,470,930	130,392	389,449	594,427	8,212,070
Increase (+) or decrease (−)	−543	+873,319	−1,219	+174,256	−108,442	+101,609	+74,205	+1,113,185

COPPER.

The copper output of Colorado in 1913 increased in quantity from 7,107,303 pounds to 7,227,826 pounds, but decreased in value from $1,172,705 to $1,120,313. Copper production was reported from 25 counties in 1913.

As usual, Lake County was the leading copper producer, yielding 27 per cent of the State output in 1913; and San Juan was second, with 17 per cent; Gilpin, Dolores, San Miguel, Ouray, Clear Creek, and Chaffee followed, in order. These 8 counties combined produced 94 per cent of the total.

Siliceous and dry ores yielded 4,110,475 pounds, or nearly 57 per cent of the copper output; copper ores, 1,701,666 pounds, or over 23 per cent; lead ores, 566,401 pounds, or nearly 8 per cent; copper-lead ores, 640,795 pounds, or nearly 9 per cent; lead-zinc ores, 206,933 pounds, or nearly 3 per cent.

Source of copper production in Colorado in 1913, by kinds of ore, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Boulder	8,852	3,767	9,998	.....	2,918	.....	25,535
Chaffee	86,344	153,371	75,198	.....	.....	98	315,011
Clear Creek	337,870	7,780	72,873	.....	7,870	.....	426,393
Custer	1,034	2,968	50	.....	.....	.....	4,052
Dolores	2,682	747,216	44,397	.....	5,315	2,209	801,819
Eagle	16,751	19,484	4,113	.....	.....	1,020	41,368
El Paso	.....	10,632	.....	.....	.....	.....	10,632
Fremont	.....	4,677	.....	.....	.....	.....	4,677
Garfield	200	.....	.....	.....	.....	.....	200
Gilpin	675,378	160,213	2,383	.....	.....	.....	837,974
Gunnison	1,580	623	402	.....	12,117	7,142	21,864
Hinsdale	838	58,894	5,202	.....	.....	11,370	76,304
Lake	1,434,938	353,572	55,109	1,556	3,120	75,692	1,923,987
La Plata	1,783	112,114	.....	.....	.....	.....	113,897
Mineral	20,595	.....	6,084	.....	.....	4,968	31,647
Montrose	.....	24,058	.....	.....	.....	.....	24,058
Ouray	464,592	23,176	3,969	.....	5,970	2,622	500,329
Park	20,876	1,214	2,703	.....	3,146	1,222	29,161
Pitkin	227	.....	48,625	.....	.....	.....	48,852
Rio Grande	.....	568	.....	.....	.....	.....	568
Routt	52	.....	109	.....	.....	.....	161
Saguache	501	280	9,501	.....	2,842	153	13,277
San Juan	299,148	17,059	212,867	.....	597,497	94,945	1,221,516
San Miguel	732,029	.....	4,345	.....	.....	.....	736,374
Summit	4,205	.....	8,473	.....	.....	5,492	18,170
Total, 1913	4,110,475	1,701,666	566,401	1,556	640,795	206,933	7,227,826
Total, 1912	4,196,096	1,622,605	539,216	67,012	531,227	151,147	7,107,303
Increase (+) or decrease (−)	−85,621	+79,061	+27,185	−65,456	+109,568	+55,786	+120,523

LEAD.

The lead production in Colorado in 1913 was 87,897,773 pounds, valued at $3,867,502, as against 75,242,267 pounds, valued at $3,385,902, in 1912, an increase of 12,655,506 pounds in quantity and of $481,600 in value.

There were marked increases in Chaffee, Clear Creek, Dolores, Lake, Park, Pitkin, and San Juan counties. Decreases of note were made in Gilpin, Gunnison, Hinsdale, Mineral, Ouray, San Miguel, and Summit counties.

In rank, Lake County led, with 29,286,183 pounds; Pitkin was second, with 17,528,386 pounds; San Juan was third, with 9,508,979 pounds; San Miguel was fourth, with 6,967,136 pounds; Clear Creek was fifth, with 3,999,614 pounds; Summit was sixth, with 3,944,268 pounds; and Mineral, Chaffee, Dolores, Ouray, Eagle, and Gilpin followed in order. There was an increase of 23,029 tons in the tonnage of lead ores produced and a decrease of 25,740 tons in that of lead-zinc ores. Siliceous and dry ores yielded 24,056,425 pounds, or 27 per cent of the lead output; lead ores, 39,397,770 pounds, or 45 per cent; lead-zinc ores, 23,317,335 pounds, or almost 27 per cent; copper and copper-lead ores combined, 985,817 pounds, or 1 per cent.

Source of lead production in Colorado in 1913, by kinds of ore, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Boulder	16,312	337	383,269	.....	9,582	.....	409,500
Chaffee	1,675,866	755	1,514,584	2,417	.....	2,923	3,196,545
Clear Creek	1,818,881	493	2,061,221	.....	22,566	96,453	3,999,614
Custer	3,537	.....	1,736	.....	.....	.....	5,273
Dolores	8,768	2,276	777,382	.....	13,460	2,277,455	3,079,341
Eagle	11,003	695	256,653	.....	.....	1,082,854	1,351,205
Fremont	.....	.....	.....	.....	.....	4,591	4,591
Gilpin	1,127,406	5,232	77,703	.....	.....	.....	1,210,341
Gunnison	17,817	103	108,677	.....	8,795	61,336	196,728
Hinsdale	3,521	6,198	701,307	.....	.....	71,292	782,318
Lake	6,217,529	142,373	8,811,431	138,009	12,299	13,964,542	29,286,183
La Plata	4,116	339	.....	.....	.....	.....	4,455
Mineral	986,281	.....	977,213	.....	.....	1,434,870	3,398,364
Ouray	1,959,067	8,333	171,277	.....	13,445	28,469	2,180,591
Park	271,430	362	212,985	.....	8,604	12,665	506,046
Pitkin	190,122	.....	17,338,264	.....	.....	.....	17,528,386
Routt	332	.....	691	.....	.....	.....	1,023
Saguache	.....	.....	295,965	.....	22,667	18,254	336,886
San Juan	3,013,125	6,250	3,982,858	.....	700,653	1,806,093	9,508,979
San Miguel	6,563,452	.....	403,684	.....	.....	.....	6,967,136
Summit	167,860	.....	1,320,870	.....	.....	2,455,538	3,944,268
Total, 1913	24,056,425	173,746	39,397,770	140,426	812,071	23,317,335	87,897,773
Total, 1912	20,162,526	102,321	29,640,633	1,235,019	1,260,482	22,841,286	75,242,267
Increase (+) or decrease (−)	+3,893,899	+71,425	+9,757,137	−1,094,593	−448,411	+476,049	+12,655,506

ZINC.[1]

In 1913 the marketed zinc ores from Colorado contained 119,346,429 pounds of recoverable zinc (figured as spelter and zinc in zinc oxide), valued at $6,683,400, as compared with 132,222,812 pounds, valued at $9,123,374, in 1912. In 1913 the quantity of zinc produced was 31,448,656 more pounds than that of lead, and the value was $2,815,898 more than the value of lead and $1,050,946 more than the value of silver.

Zinc ores furnished 66,305,374 pounds, or 56 per cent of the total zinc yield; lead-zinc ores, 46,354,469 pounds, or 39 per cent; and siliceous and dry ores, 6,686,586 pounds, or more than 5 per cent.

[1] For interesting discussion of zinc smelting and treatment of residues see Leslie, H. E., Zinc smelting at Bartlesville, Okla.; National Zinc Co., Bartlesville; Collinsville smelter of the Bartlesville Smelting Co., Hillsboro, Ill.; Rose Lake smelter of the Granby Co.; and Mineral Point smelter at Depue, Ill.: Min. and Sci. Press, vol. 109, pp. 44–49, July 11, 1914. Also see Stone, George C. (chief engineer New Jersey Zinc Co.), Belgian furnaces in zinc smelting; Min. and Sci. Press, pp. 931–932, Dec. 13, 1913.

Lake County produced 79 per cent of the zinc yield of the State, with an output of 93,842,857 pounds, a decrease of 12,102,926 pounds for the year. Leadville zinc carbonate shipments, which in 1911 were only 83,905 tons of 31 per cent zinc and in 1912, 142,782 tons of 29.2 per cent zinc, amounted to 135,760 tons of 27.45 per cent zinc in 1913; the tonnage of zinc sulphide sold or treated in 1913 decreased from 104,148 tons of 24 per cent zinc in 1912 to 97,704 tons of 23 per cent zinc.

Increased production of zinc was made in Chaffee, Dolores, Eagle, and Mineral counties, and appreciable decreases were made in Clear Creek, Gunnison, Lake, Saguache, San Juan, San Miguel, and Summit counties. After Lake County, Summit and Eagle counties are, respectively, second and third in the output of zinc.

Zinc output from concentrates in 1913 amounted to 41,692,027 pounds and in crude ore shipped direct to 77,654,402 pounds.

The following tables show the tonnages of zinc ore and concentrates:

Zinc ore and concentrates as marketed at the mine or mill,[a] in Colorado, in 1913, by counties and districts, in short tons.

County and district.	Classification.	Quantity.	Average crude assay of zinc.
			Per cent.
Chaffee (ore and concentrates), Fremont (ore), Gunnison (ore and concentrates), Park (ore), Pitkin (ore), Saguache (ore and concentrates).	Ore and concentrates	4,686	38.20
Mineral	Concentrates	769	36.07
Lake	Zinc (lead) sulphide ore and a few concentrates.[b]	95,932	23.00
	Zince carbonate ore	135,760	27.45
Eagle and Summit	Ore and concentrates	19,223	42.04
Clear Creek (ore, concentrates, and middlings) and Gilpin (concentrates).	Ore, concentrates, and middlings.	2,323	38.30
San Juan region: Dolores (ore and concentrates), Hinsdale (ore and concentrates), Ouray (ore and concentrates), San Juan (concentrates), San Miguel (concentrates [c]).	Ore and concentrates	13,004	32.02
Total	Ore, concentrates, and middlings.	271,697	27.30
SUMMARY.			
Lake	Crude ore	231,692	25.45
All other counties	Ore concentrates, and middlings.	40,005	38.00
Total	....do	271,697	27.30
Total carbonate ore	Ore	137,240	27.49
Total sulphide ore	Ore, concentrates, and middlings.	134,457	27.10

[a] Tonnage of crude ore and contents as shipped to custom plants at Denver and Canon City, not the product from these mills, in order to conceal individual production.

[b] The bulk concentrated at Canon City, Pueblo, and Denver; the remainder to zinc smelters and zinc oxide plants, chiefly in Kansas and Oklahoma. Concentrates range from 40 to 50 per cent zinc and are shipped to Kansas, Oklahoma, Illinois, Wisconsin, and eastern points.

[c] Reconcentrated and smelted at plant of United States Zinc Co., Pueblo.

Source of zinc production in Colorado in 1913, by kinds of ore, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Zinc ores.	Lead-zinc ores.	Total.
Chaffee	1,494,835	621,721	5,391	2,121,947
Clear Creek	1,381,562	.....	107,956	1,489,518
Dolores	.....	164,710	2,431,522	2,596,232
Eagle	.....	20,624	6,663,019	6,683,643
Fremont	.....	.....	7,161	7,161
Gilpin	8,589	.....	.....	8,589
Gunnison	.....	.....	292,875	292,875
Hinsdale	.....	.....	54,732	54,732
Lake	.....	64,744,523	29,098,334	93,842,857
Mineral	.....	.....	454,875	454,875
Ouray	117,718	.....	82,711	200,429
Park	.....	26,768	71,855	98,623
Pitkin	.....	460,161	.....	460,161
Saguache	.....	24,391	8,573	32,964
San Juan	1,278,132	.....	386,867	1,664,999
San Miguel	2,405,750	.....	.....	2,405,750
Summit	.....	242,476	6,688,598	6,931,074
Total, 1913	6,686,586	66,305,374	46,354,469	119,346,429
Total, 1912	4,554,875	84,989,652	42,678,285	132,222,812
Increase (+) or decrease (−)	+2,131,711	−18,684,278	+3,676,184	−12,876,383

ORE TONNAGES AND METAL CONTENT.

Subdivision of crude ore sold or treated in Colorado in 1913, by counties, in short tons.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Boulder	4,414	43	1,234	.....	28	.....	5,719
Chaffee	36,959	994	10,006	1,161	.....	15	49,135
Clear Creek	97,638	118	6,555	.....	97	484	104,892
Custer	4,608	38	16	.....	.....	.....	4,662
Dolores	735	7,417	2,883	204	84	6,479	17,802
Eagle	4,617	168	1,035	36	.....	41,632	47,488
El Paso	.....	298	.....	.....	.....	.....	298
Fremont	.....	28	.....	.....	.....	25	53
Garfield	25	.....	.....	.....	.....	.....	25
Gilpin	92,350	1,547	259	.....	.....	.....	94,156
Gunnison	3,033	9	439	.....	66	754	4,301
Hinsdale	151	138	3,360	.....	.....	680	4,329
Lake	247,687	3,991	43,144	138,672	25	94,792	528,311
La Plata	6,049	1,354	.....	.....	.....	.....	7,403
Mineral	28,963	.....	8,149	.....	.....	19,651	56,763
Montrose	.....	49	.....	.....	.....	.....	49
Ouray	96,517	191	365	.....	67	196	97,336
Park	5,294	13	1,089	44	44	114	6,598
Pitkin	11,202	.....	102,245	817	.....	.....	114,264
Rio Grande	.....	6	.....	.....	.....	.....	6
Routt	7	.....	5	.....	.....	.....	12
Saguache	27	6	582	44	38	283	980
San Juan	81,579	147	18,194	.....	5,968	17,455	123,343
San Miguel	508,300	.....	875	.....	.....	.....	509,175
Summit	13,897	.....	5,339	317	.....	20,807	40,360
Teller	917,406	.....	.....	.....	.....	.....	917,406
Total, 1913	[a]2,161,458	16,555	205,774	141,295	6,417	203,367	2,734,866
Total, 1912	1,966,300	13,718	182,745	177,946	6,810	229,107	2,576,626
Increase (+) or decrease (−)	+195,158	+2,837	+23,029	−36,651	−393	−25,740	+158,240
Average recovered value in gold and silver per ton	$9.57	$17.65	$7.53	$0.10	$51.73	$2.47	$8.54

[a] This tonnage is divided into 1,125,535 tons of gold ore, 274,116 tons of silver ore, and 761,807 tons of gold and silver ore.

Content of dry and siliceous gold and silver ores sold or treated in Colorado in 1913, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	4,414	3,127.96	90,552	8,852	16,312	.....
Chaffee	36,959	5,520.17	49,337	86,344	1,675,866	1,494,835
Clear Creek	97,638	18,047.84	262,165	337,870	1,818,881	1,381,562
Custer	4,608	710.19	10,240	1,034	3,537	.....
Dolores	735	329.28	29,867	2,682	8,768	.....
Eagle	4,617	1,532.57	220,322	16,751	11,003	.....
Garfield	25	43.05	35	200	.....	.....
Gilpin	9?,350	28,774.75	255,634	675,378	1,127,406	8,589
Gunnison	3,033	449.52	47,054	1,580	17,817	.....
Hinsdale	151	48.93	11,141	838	3,521	.....
Lake	247,687	37,903.51	2,498,297	1,434,938	6,217,529	.....
La Plata	6,049	15,135.95	118,414	1,733	4,116	.....
Mineral	28,963	712.00	715,919	20,595	986,281	.....
Ouray	96,517	46,132.11	493,422	464,592	1,959,067	117,718
Park	5,294	517.57	77,558	20,876	271,430	.....
Pitkin	11,202	1.02	130,482	227	190,122	.....
Routt	7	11.08	1,919	52	332	.....
Saguache	27	31.01	37	501	.....	.....
San Juan	81,579	25,651.11	165,929	299,148	3,013,125	1,278,132
San Miguel	508,300	102,953.20	998,958	732,029	6,563,452	2,405,750
Summit	13,897	1,902.85	22,127	4,205	167,860	.....
Teller	917,406	527,529.52	71,349	.....	.....	.....
Total	2,161,458	817,065.19	6,270,758	4,110,475	24,056,425	6,686,586

Content of copper ores sold or treated in Colorado in 1913, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Boulder	43	62.58	9.8	3,767	337
Chaffee	994	19.35	3,117	153,371	755
Clear Creek	118	144.25	3,748	7,780	493
Custer	38	.12	139	2,968	.....
Dolores	7,417	143.90	42,028	747,216	2,276
Eagle	168	172.99	3,018	19,484	695
El Paso	298	.....	.....	10,632	.....
Fremont	28	4.45	63	4,677	.....
Gilpin	1,547	4,205.29	13,581	160,213	5,232
Gunnison	9	.....	104	623	103
Hinsdale	138	25.73	6,966	58,894	6,198
Lake	3,991	2,545.36	139,514	353,572	142,373
La Plata	1,354	.15	2,708	112,114	339
Montrose	49	.24	427	24,058	.....
Ouray	191	226.10	4,182	23,176	8,333
Park	13	50.87	326	1,214	362
Rio Grande	6	9.29	109	568	.....
Saguache	6	1.60	9	280	.....
San Juan	147	3.65	2,101	17,059	6,250
Total	16,555	7,615.92	223,108	1,701,666	173,746

Content of lead ores sold or treated in Colorado in 1913, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Boulder	1,234	160.06	63,848	9,998	383,269
Chaffee	10,006	9,531.88	115,845	75,198	1,514,584
Clear Creek	6,555	2,437.79	134,837	72,873	2,061,221
Custer	16	.03	934	50	1,736
Dolores	2,883	97.84	43,795	44,397	777,382
Eagle	1,035	17.55	51,347	4,113	256,653
Gilpin	259	235.15	3,989	2,383	77,703
Gunnison	439	8.84	35,509	402	108,677
Hinsdale	3,360	166.91	10,240	5,202	701,307
Lake	43,144	7,252.25	318,009	55,109	8,811,431
Mineral	8,149	688.84	20,705	6,084	977,213
Ouray	365	19.72	35,464	3,909	171,277
Park	1,089	1,104.76	12,453	2,703	212,985
Pitkin	102,245	.38	431,826	48,625	17,338,264
Routt	5	.10	35	109	691
Saguache	582	146.67	7,792	9,501	295,965
San Juan	18,194	3,398.27	203,078	212,867	3,982,858
San Miguel	875	55.12	52,138	4,345	403,684
Summit	5,339	1,529.62	104,342	8,473	1,320,870
Total	205,774	26,845.88	1,645,186	566,401	39,397,770

Content of zinc ores sold or treated in Colorado in 1913, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Chaffee	1,161				2,417	621,721
Dolores	204					164,710
Eagle	36					20,624
Lake	138,672	73.92	21,950	1,556	138,009	64,744,523
Park	44					26,768
Pitkin	817					460,161
Saguache	44					24,391
Summit	317					242,476
Total	141,295	73.92	21,950	1,556	140,426	66,305,374

Content of copper-lead ores sold or treated in Colorado in 1913, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Boulder	28	0.53	7,016	2,918	9,582
Clear Creek	97	214.73	1,413	7,870	22,566
Dolores	84	1.85	2,482	5,315	13,460
Gunnison	66	4.02	1,871	12,117	8,795
Lake	25	429.68	1,333	3,120	12,299
Ouray	67	2.00	2,669	5,970	13,445
Park	44	.51	3,328	3,146	8,601
Saguache	38	13.21	441	2,842	22,667
San Juan	5,968	1,043.46	470,505	597,497	700,653
Total	6,417	1,709.99	491,058	640,795	812,071

Content of lead-zinc ores sold or treated in Colorado in 1913, by counties.

County.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Chaffee	15	3.50	671	98	2,923	5,391
Clear Creek	484	77.05	6,364		96,453	107,956
Dolores	6,479	28.53	60,644	2,209	2,277,455	2,431,522
Eagle	41,632	270.91	26,693	1,020	1,082,854	6,663,019
Fremont	25		15		4,591	7,161
Gunnison	754	1.44	2,942	7,142	61,336	292,875
Hinsdale	680	19.85	2,130	11,370	71,292	54,732
Lake	94,792	1,313.33	421,215	75,692	13,964,542	29,098,334
Mineral	19,651	1,031.55	68,719	4,968	1,434,870	454,875
Ouray	196	29.93	1,897	2,622	28,469	82,711
Park	114	33.10	489	1,222	12,665	71,855
Saguache	283	12.77	415	153	18,254	8,573
San Juan	17,455	1,715.49	38,796	94,945	1,806,093	386,867
Summit	20,807	245.59	37,642	5,492	2,455,538	6,688,598
Total	203,367	4,733.04	668,632	206,933	23,317,335	46,354,469

MINING INDUSTRY IN COLORADO IN 1913.

The output of Colorado mines during 1913 was $18,146,916 in gold, 9,325,255 fine ounces of silver, 87,897,773 pounds of lead, 7,227,826 pounds of copper, and 119,346,429 pounds of zinc (in terms of spelter and zinc in zinc oxide), with a total gross value of recovered metals of $35,450,585, as compared with $37,320,966 in 1912, a decrease in value for 1913 of $1,870,381, or 5 per cent. There was a decrease of $441,646 in gold, an increase of 1,113,185 ounces of silver, an increase of 12,655,506 pounds of lead, an increase of 120,523 pounds of copper, and a decrease of 12,876,383 pounds of zinc. The heaviest decrease

in value was $2,439,974 for zinc, but there were increases of $582,031 for silver and $481,600 for lead.

The tonnage treated by the Globe, Leadville, Pueblo, Durango, and Salida smelters from British Columbia, Canada, Colorado, Idaho, South Dakota, Utah, and other States, including a considerable tonnage of zinc residues from Kansas and Oklahoma zinc smelters, showed a small increase for the year, but, as has been the case for several years, the plants were not operated to full capacity. An increased tonnage from Colorado was shipped to the Garfield, Midvale, and Murray plants in Utah. Cyanide precipitates and ore were shipped from Colorado to Omaha. The United States Zinc Co.'s magnetic plant and zinc smelter at Pueblo were operated steadily on zinc-lead ores from various counties in Colorado, and also from Arizona, Idaho, Montana, Nevada, and Utah. The Western Chemical Co.'s sulphuric acid, magnetic separation, and wet-concentration plant at Denver was operated steadily, as was the Empire Zinc Co.'s magnetic separation plant at Canon City, both treating chiefly Leadville and lead-zinc ores. The Sutton Steele & Steele dry concentration and static electric separation plant was operated throughout the year on many test lots and later on custom ore purchased from various districts in the State.

The following list gives the active smelting plants in Colorado in 1913:

List of active smelting plants in Colorado in 1913.

City.	Plant.	Owner.	Class of ore.	Production.	Total furnaces.[a]
Denver	Globe	American Smelting and Refining Co.	Lead base[b]	Lead bullion and copper matte.	7
Pueblo	Pueblo	do	do	do	7
Leadville	Arkansas Valley	do	do	do	10
Durango	Durango	do	do	do	4
Salida	Salida	Ohio and Colorado Smelting and Refining Co.	do	do	4
Pueblo	United States Zinc Co.	American Smelting and Refining Co.	Zinc - lead - copper-gold-silver.	Spelter and zinc dust.	1,920 Retorts.
Ouray	Brown Mountain	Brown Mountain Smelting and Refining Co.	Pyritic copper	Copper matte	1

[a] Not all used.
[b] Copper ores and copper in other ores are handled by occasionally turning a lead furnace into a copper furnace.

Cripple Creek produced 60 per cent of the total gold yield of the State, with a value of $10,905,003, as compared with $11,008,362 in 1912. The output for 11 months from Cripple Creek seemed to indicate a production for 12 months of $11,184,000, but the severe storm of December 4, 1913, so crippled transportation facilities that the December yield fell off heavily. There was an increased yield of gold bullion from custom cyanidation plants at Colorado Springs and from the cyanidation mills in the district, the decreased yield being due to a decreased tonnage of smelting ore. The Roosevelt tunnel continued to lower the water level gradually. In the Vindicator and Golden Cycle mines electric pumps were installed. Lower levels were opened in various properties.

The Golden Cycle and Portland cyanidation mills at Colorado Springs were operated steadily. The Portland, Stratton's Independence, Ajax, and several other cyanidation plants in the district were operated continuously. The Standard chlorination and cyanidation plant at Colorado City was idle; but the Union cyanidation plant, at Florence, was operated part of the year on old tailings. The public report of the Portland Co. for 1913 shows that a total of 178,162 tons of an average assay value of $2.95 per ton was treated at the Portland Co.'s Victor mill with satisfactory net earnings. The Stratton's Independence report shows a recovery of 78.48 per cent on ore averaging $3.076 per ton, the cost of working the mill being $1.46 per ton.

Lake County (chiefly Leadville, but for 1913 including the new Lackawanna district, in addition to Big English Gulch and Sugar Loaf districts), produced $1,023,631 in gold, 3,400,318 ounces of silver (which represents 36 per cent of the State yield), 1,923,987 pounds of copper, 29,286,183 pounds of lead, and 93,842,857 pounds of zinc (representing 79 per cent of the State yield), with a total value of $9,919,433, as against $11,780,131 in 1912. The output of zinc carbonate was 135,760 tons of 27.45 per cent zinc, as against 142,782 tons of 29.2 per cent zinc in 1912. The quantity of zinc sulphide shipped was 95,932 tons of 23 per cent zinc, as compared with 104,148 tons of 24 per cent zinc in 1912. Other classes of ore from Leadville showed little change from 1912. The zinc carbonate ore was treated at zinc oxide plants and zinc smelters in Kansas, Oklahoma, Illinois, and Wisconsin. The larger part of the zinc and zinc-lead sulphide ore was first treated at the sulphuric-acid plant and magnetic separation and wet-concentration plant of the Western Chemical Co., at Denver; at the magnetic separation plant of the Empire Zinc Co., at Canon City; at the magnetic plant of the United States Zinc Co., at Pueblo; a small tonnage being also treated at the Leadville district mill by wet concentration, at Leadville. Zinc concentrates and the remainder of the zinc and zinc-lead sulphide ores were treated at sulphuric-acid plants, zinc oxide plants, and zinc smelters in Colorado, Kansas, Oklahoma, Illinois, Ohio, West Virginia, and Wisconsin. Lead and iron concentrates from the milling plants, and residues from the sulphuric-acid plants and zinc smelters were (in some cases) returned to lead smelters in Colorado, where were recovered part of the gold, silver, copper, and lead contained in the original ores.

The San Juan region of Dolores, La Plata, Ouray, San Juan, and San Miguel counties producted $4,071,683 in gold, 2,769,077 ounces of silver, 3,373,935 pounds of copper, 21,740,502 pounds of lead, and 6,867,410 pounds of zinc, with a total value of $7,608,323, as compared with $4,115,345 in gold, 2,562,096 ounces of silver, 3,000,173 pounds of copper, 20,752,156 pounds of lead, and 6,375,073 pounds of zinc, with a total value of $7,559,790 in 1912. There was an increase for gold of $4,876 in Dolores, $177,500 in La Plata, and $134,038 in San Juan; and a decrease of $90,213 in Ouray and of $269,863 in San Miguel. There was an increase for silver of 78,528 ounces in Dolores, 165,435 ounces in San Juan, and 73,174 ounces in La Plata, and a decrease of 102,613 ounces in San Miguel County. Dolores County (Rico) made a large increase in the yield of copper, lead, and zinc, but the production of lead fell off heavily in San Miguel and Ouray counties.

Chaffee County produced $312,892 in gold, 168,985 ounces of silver, 315,011 pounds of copper, 3,196,545 pounds of lead, and 2,121,947 pounds of zinc, with a total value of $723,263, as compared with $279,387 in 1912.

Boulder County's yield of gold bullion decreased almost one-half and there was also a decrease of 1,900 ounces of gold in ore smelted, but the silver output increased 90,049 ounces, and the lead 103,678 pounds. The total value for 1913 was $189,330, as compared with $181,333 in 1912.

Clear Creek County's output was $432,489 in gold, 408,527 ounces of silver, 426,393 pounds of copper, 3,999,614 pounds of lead, and 1,489,518 pounds of zinc, with a total value of $1,004,726, as compared with $1,028,166 in 1912. Gilpin County's output decreased $217,404 in gold and 42,998 ounces of silver, with decreases for lead and copper, the total value being $1,035,740, as compared with $1,330,796 in 1912. Ore mined in Gilpin County through the Newhouse tunnel has been accredited to Gilpin County.

The Pitkin County (Aspen) yield was 562,308 ounces of silver and 17,528,386 pounds of lead, an increase of 33,804 ounces and 9,123,053 pounds, respectively.

Creede (Mineral County) produced $50,282 in gold, 805,343 ounces of silver, 31,647 pounds of copper, 3,398,364 pounds of lead, and 454,875 pounds of zinc, with a total value of $716,615, as compared with $808,771 in 1912. The output of Hinsdale County showed a decrease of 475,482 pounds of lead. Owing to the closing of the Gold Links mine at Ohio, Gunnison County's output of bullion, ore, and concentrates showed a heavy decrease for gold. Lead and zinc production also decreased, but there was an appreciable increase in silver output, owing to the opening of mines at Whitepine and on Italian Mountain. The output of placer gold from dredges and other placer operations at Breckenridge, Summit County, was $386,196, as compared with $392,739 in 1912, but the yield of considerable high-grade ore from pocket mines at Breckenridge and increased content of gold in smelting ore and concentrates from Kokomo, Breckenridge, and Montezuma combined gave a total yield of gold for the county of $462,228, as against $426,015 in 1912. Silver and copper yields also increased, but the yield of zinc decreased, owing to the closing of the wet mill of the Wellington Co. during the latter part of the year, although the magnetic plant continued to be operated. The output of Eagle County, from Red Cliff and from Eagle (a new producing silver district in 1913, with a yield of 181,141 ounces), was $41,220 in gold, 301,380 ounces of silver, 41,368 pounds of copper, 1,351,205 pounds of lead, and 6,683,643 pounds of zinc, with a total value of $663,403, as against $620,571 in 1912. Park County's output of silver, lead, and copper increased, more than balancing an appreciable decrease in gold.

The following table shows the production of gold, silver, copper, lead, and zinc in Colorado, by counties:

Mine production of gold, silver, copper, lead, and zinc in 1913 in Colorado, by counties.

County.	Producing mines.	Tonnage of deep mines.	Gold.[a]		Silver.[a]	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
Boulder	121	5,719	3,351.13	$69,274	162,384	$98,080
Chaffee	18	49,135	15,136.15	312,892	168,985	102,067
Clear Creek	105	104,892	20,921.66	432,489	408,527	246,750
Costilla	1	.....	4.59	95	2	1
Custer	7	4,662	710.34	14,684	11,313	6,833
Dolores	8	17,802	601.40	12,432	178,816	108,005
Douglas	1	.....	26.46	547	2	1
Eagle	29	47,488	1,994.02	41,220	301,380	182,034
El Paso	1	298	.....	.....	.....	.....
Fremont	2	53	4.45	92	78	47
Garfield	1	25	43.05	890	35	21
Gilpin	122	94,156	33,238.51	687,101	273,207	165,017
Gunnison	19	4,301	492.89	10,189	87,488	52,843
Hinsdale	14	4,329	255.42	5,280	30,477	18,408
Lake	91	528,311	49,518.15	1,023,631	3,400,318	2,053,792
La Plata	24	7,403	15,136.10	312,891	121,122	73,158
Mineral	12	56,763	2,432.39	50,282	805,343	486,427
Moffat	6	.....	172.21	3,560	8	5
Montrose	5	49	45.47	940	434	262
Ouray	31	97,336	46,403.86	959,377	537,634	324,731
Park	25	6,598	2,420.73	50,041	94,293	56,953
Pitkin	13	114,264	1.40	29	562,308	339,634
Rio Grande	2	6	11.76	243	109	66
Routt	3	12	13.55	280	1,954	1,180
Saguache	10	980	205.26	4,243	8,694	5,251
San Juan	38	123,343	31,811.98	657,612	880,409	531,767
San Miguel	27	509,175	103,008.32	2,129,371	1,051,096	634,862
Summit	45	40,360	22,300.29	462,228	167,490	101,164
Teller	77	917,406	527,529.52	10,905,003	71,349	43,095
Total, 1913	858	2,734,866	877,857.06	18,146,916	9,325,255	5,632,454
Total, 1912	856	2,576,626	899,221.69	18,588,562	8,212,070	5,050,423
Increase (+) or decrease (−)	+2	+158,240	−21,364.63	−441,646	+1,113,185	+582,031

[a] Includes placer production.

Mine production of gold, silver, copper, lead, and zinc in 1913 in Colorado, by counties— Continued.

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Boulder	25,535	$3,958	409,500	$18,018	.....	.....	$189,330
Chaffee	315,011	48,827	3,196,545	140,648	2,121,947	$118,829	723,263
Clear Creek	426,393	66,091	3,999,614	175,983	1,489,518	83,413	1,004,726
Costilla	.....	.....	.....	.....	.....	.....	96
Custer	4,052	628	5,273	232	.....	.....	22,377
Dolores	801,819	124,282	3,079,341	135,491	2,596,232	145,389	525,599
Douglas	.....	.....	.....	.....	.....	.....	548
Eagle	41,368	6,412	1,351,205	59,453	6,683,643	374,284	663,403
El Paso	10,632	1,648	.....	.....	.....	.....	1,648
Fremont	4,677	725	4,591	202	7,161	401	1,467
Garfield	200	31	.....	.....	.....	.....	942
Gilpin	837,974	129,886	1,210,341	53,255	8,589	481	1,035,740
Gunnison	21,864	3,389	196,728	8,656	292,875	16,401	91,478
Hinsdale	76,304	11,827	782,318	34,422	54,732	3,065	73,002
Lake	1,923,987	298,218	29,286,183	1,288,592	93,842,857	5,255,200	9,919,433
La Plata	113,897	17,654	4,455	196	.....	.....	403,899
Mineral	31,647	4,905	3,398,364	149,528	454,875	25,473	716,615
Moffat	.....	.....	.....	.....	.....	.....	3,565
Montrose	24,058	3,729	.....	.....	.....	.....	4,931
Ouray	500,329	77,551	2,180,501	95,946	200,429	11,224	1,468,829
Park	29,161	4,520	536,046	22,266	98,623	5,523	139,303
Pitkin	48,852	7,572	17,528,386	771,249	460,161	25,769	1,144,253
Rio Grande	568	88	.....	.....	.....	.....	397
Routt	161	25	1,023	45	.....	.....	1,530
Saguache	13,277	2,058	336,886	14,823	32,964	1,846	28,221
San Juan	1,221,516	189,335	9,538,979	418,395	1,664,999	93,240	1,890,349
San Miguel	736,374	114,138	6,967,136	306,554	2,495,750	134,722	3,319,647
Summit	18,170	2,816	3,944,268	173,548	6,931,074	388,140	1,127,806
Teller	.....	.....	.....	.....	.....	.....	10,948,098
Total, 1913	7,227,826	1,120,313	87,897,773	3,867,502	119,346,429	6,683,400	35,450,585
Total, 1912	7,107,303	1,172,705	75,242,267	3,385,902	132,222,812	9,123,374	37,320,966
Increase (+) or decrease (−)	+120,523	−52,392	+12,655,506	+481,600	−12,876,383	−2,439,974	−1,870,381

Tonnage of ore sold or treated, number of deep mines producing, and average value per ton of ore from deep mines in Colorado in 1912 and 1913, by counties.

County.	Ore sold or treated.			Number of deep mines producing.		Average value per ton.	
	1912	1913	Increase (+) or decrease (−).	1912	1913	1912	1913
	Short tons.	*Short tons.*	*Short tons.*				
Boulder	9,838	5,719	− 4,119	126	121	$18.43	$33.11
Chaffee	10,287	49,135	+ 38,848	16	16	26.71	14.69
Clear Creek	102,894	104,892	+ 1,998	88	105	9.99	9.58
Custer	4,330	4,662	+ 332	8	7	7.70	4.80
Dolores	8,485	17,802	+ 9,317	7	8	34.60	29.52
Eagle	34,164	47,488	+ 13,324	18	29	18.16	13.97
El Paso	.....	298	+ 298	.....	1	.....	5.53
Fremont	1,015	53	− 962	1	2	41.07	27.68
Garfield	.....	25	+ 25	.....	1	.....	37.68
Gilpin	118,652	94,156	− 24,496	151	120	11.22	11.00
Gunnison	14,046	4,301	− 9,745	12	18	13.60	21.13
Hinsdale	9,554	4,329	− 5,225	12	14	9.89	16.86
Lake	507,591	528,311	+ 20,720	100	91	23.21	18.78
La Plata	2,761	7,403	+ 4,642	23	24	59.88	54.56
Mesa	22	.....	− 22	1	.....	50.27	.....
Mineral	66,488	56,763	− 9,725	10	12	12.16	12.62
Moffat	64	.....	− 64	1	.....	65.84	.....
Montrose	.....	49	+ 49	.....	2	.....	81.47
Ouray	89,975	97,336	+ 7,361	35	31	17.73	15.09
Park	2,686	6,598	+ 3,912	20	21	32.10	18.86
Pitkin	91,791	114,264	+ 22,473	9	13	8.07	10.01
Rio Grande	133	6	− 127	1	1	82.78	57.67
Routt	.....	12	+ 12	.....	2	.....	123.42
Saguache	9,459	980	− 8,479	12	10	8.48	28.80
San Juan	140,917	123,343	− 17,574	41	38	12.21	15.33
San Miguel	455,696	509,175	+ 53,479	26	27	8.31	6.52
Summit	46,606	40,360	− 6,246	31	38	20.96	18.31
Teller	849,172	917,406	+ 68,234	74	77	13.01	11.93
Total	2,576,626	2,734,866	+158,240	823	829	.....	.....
Average value per ton	.....	.....	.....	.....	.....	14.32	12.81

REDUCTION MILLS IN COLORADO.

Mineral Resources for 1912, Part I, pages 650–664, 1913, contains a complete list of the reduction mills in Colorado in 1912, with description of equipment and process. Changes in this list for 1913 have been noted in the text of the various counties, and reference should be made to the 1912 report for details of equipment.

Tonnage of ore to gold and silver mills and concentrating mills, with quantity of gold and silver contained in bullion produced in Colorado in 1913, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Boulder	1,065	616.21	232	40
Chaffee	35,558	268.91	185	.....
Clear Creek	47,541	2,373.59	2,542	39,628
Custer	4,353	696.41	4,501	.....
Dolores	.....	.....	.....	6,383
Eagle	.....	.....	.....	41,040
El Paso	.....	.....	.....	84
Fremont	.....	.....	.....	25
Gilpin	33,634	4,552.38	1,204	44,428
Gunnison	1,146	177.05	165	695
Hinsdale	.....	.....	.....	3,723
Lake	9,749	2,722.59	740	64,995
La Plata	.....	169.43	26	.....
Mineral	.....	.....	.....	27,169

Tonnage of ore to gold and silver mills and concentrating mills, with quantity of gold and silver contained in bullion produced in Colorado in 1913, by counties—Continued.

County.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Ouray	54,932	21,977.31	8,210	37,303
Park	870	113.23	36	.....
Pitkin	.....	1.02	1,576	71,822
Saguache	.....	.....	.....	283
San Juan	52,056	8,790.35	3,137	60,455
San Miguel	480,609	62,939.61	377,110	27,659
Summit	.....	1,443.38	927	33,801
Teller	888,822	447,880.88	42,853	.....
Total, 1913	1,610,335	554,722.35	443,444	459,533
Total, 1912	1,435,837	544,750.93	360,490	523,063
Increase (+) or decrease (−)	+174,498	+9,971.40	+82,954	−63,530
Average content per ton	.....	0.344	0.275	.....

Mine production of gold, silver, copper, lead, and zinc from Colorado concentrates in 1913, by counties.

County.	Concentrates produced.					
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	23	24.87	131	.....	172	.....
Chaffee	4,077	4,035.55	31,693	76,421	1,580,013	1,494,835
Clear Creek	9,999	6,704.25	153,659	90,814	1,878,419	1,438,217
Dolores	5,063	68.19	63,550	2,282	2,162,302	2,200,892
Eagle	11,604	269.49	15,096	.....	995,999	6,366,387
El Paso	27	.....	.....	2,037	.....	.....
Fremont	18	.....	15	.....	4,591	7,161
Gilpin	16,988	9,958.46	167,299	395,163	963,064	8,589
Gunnison	474	107.46	2,066	6,733	49,393	260,517
Hinsdale	810	95.69	7,937	11,861	628,777	39,257
Lake	57,168	2,542.80	389,596	77,312	9,002,597	18,526,720
Mineral	3,347	1,628.52	81,752	10,847	2,277,226	454,875
Ouray	16,462	23,039.94	378,776	388,649	1,946,899	186,271
Pitkin	22,100	.....	115,552	35,679	9,400,241	.....
Saguache	34	12.78	415	153	18,254	8,573
San Juan	19,058	19,289.14	236,782	528,127	6,965,793	1,661,999
San Miguel	31,330	39,987.96	621,521	731,980	6,563,375	2,405,750
Summit	13,089	429.13	49,634	8,400	2,590,786	6,628,954
Teller	6,620	14,983.41	5,304	.....	.....	.....
Total, 1913	218,291	123,177.64	2,320,781	2,366,458	47,027,901	41,692,027
Total, 1912	224,722	133,828.61	2,415,514	2,657,882	46,092,955	46,053,954
Increase (+) or decrease (−)	−6,431	−10,650.97	−94,733	−291,424	+934,946	−4,361,927
Subdivision by kinds of concentrates:						
Dry or siliceous	45,923	51,375.83	336,679	629,256	1,585,177	.....
Copper	267	188.84	3,254	25,101	3,438	.....
Lead	108,253	66,918.94	1,654,626	1,233,036	38,922,232	.....
Zinc	24,807	309.58	107,148	9,350	1,143,052	18,710,289
Copper-lead	458	286.94	4,914	38,492	76,324	.....
Lead-zinc	38,583	4,097.51	214,160	431,223	5,297,678	22,981,738
Average content:		*Fine ounces per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Dry or siliceous	.....	1.118	7.33	0.085	1.726	.....
Copper	.....	.707	12.19	4.70	.613	.....
Lead	.....	.618	15.28	.57	17.98	.....
Zinc	.....	.0125	4.32	.02	2.30	[a] 42.67
Copper-lead	.....	.627	10.73	4.20	8.33	.....
Lead-zinc	.....	.106	5.55	.56	6.865	[a] 35.34

[a] Crude assay; no deduction for loss in smelting.

Mine production of gold, silver, copper, lead, and zinc from Colorado crude ore shipped to smelters in 1913, by counties.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	4,614	2,710.05	162,021	25,535	409,328	.....
Chaffee	13,577	10,770.44	137,092	238,590	1,616,532	627,112
Clear Creek	17,723	11,843.82	252,326	335,579	2,121,195	51,301
Custer	309	13.93	6,812	4,052	5,273	.....
Dolores	11,419	533.21	115,266	799,537	917,039	395,340
Eagle	6,448	1,724.53	286,284	41,368	355,206	317,256
El Paso	214	.....	.....	8,595	.....	.....
Fremont	28	4.45	63	4,677	.....	.....
Garfield	25	43.05	35	200	.....	.....
Gilpin	16,094	18,704.35	104,701	442,811	247,277	.....
Gunnison	2,460	179.31	85,249	15,131	147,335	32,328
Hinsdale	606	159.73	22,540	64,443	153,541	15,475
Lake	453,567	44,252.76	3,009,982	1,846,675	20,283,586	75,316,137
La Plata	7,403	14,966.67	121,096	113,897	4,455	.....
Mineral	29,594	803.87	723,591	20,800	1,121,138	.....
Montrose	49	.24	427	24,058	.....	.....
Ouray	5,101	1,392.61	150,648	111,680	233,692	14,158
Park	5,728	1,593.58	94,118	29,161	506,046	98,623
Pitkin	42,442	.38	445,180	13,173	8,128,145	460,161
Rio Grande	6	9.29	109	568	.....	.....
Routt	12	11.18	1,954	161	1,023	.....
Saguache	697	192.48	8,279	13,124	318,632	24,391
San Juan	10,832	3,732.49	640,490	693,389	2,543,186	.....
San Miguel	907	80.75	52,462	4,394	403,761	.....
Summit	6,559	1,805.55	112,550	9,770	1,353,482	302,120
Teller	28,584	64,665.23	23,192	.....	.....	.....
Total, 1913	664,998	180,193.95	6,556,467	4,861,368	40,869,872	77,654,402
Total, 1912	617,726	193,013.43	5,425,366	4,449,421	29,149,312	86,168,858
Increase (+) or decrease (−)	+47,272	−12,819.48	+1,131,101	+411,947	+11,720,560	−8,514,456
Subdivision by kinds of ore:						
Dry or siliceous	358,315	146,041.36	4,101,359	2,126,493	7,966,884	.....
Copper	16,471	7,615.92	223,108	1,699,629	173,746	.....
Lead	111,110	24,593.13	1,666,423	386,598	26,505,723	.....
Zinc	141,295	73.92	21,950	1,556	140,426	66,305,374
Copper-lead	6,417	1,709.99	491,058	640,795	812,071	.....
Lead-zinc	31,390	159.63	52,569	6,297	5,271,022	11,349,028
		Fine ounces per ton.	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Average content:						
Dry and siliceous	.....	0.408	11.45	0.30	1.11	.....
Copper	.....	.462	13.55	5.16	.53	.....
Lead	.....	.221	15.00	.17	11.93	.....
Zinc	.....	.....	.....	.....	.....	[a] 27.61
Copper-lead	.....	.266	76.52	4.99	6.33	.....
Lead-zinc	.....	.005	1.67	.01	8.40	[a] 22.32

[a] Average assay; no deduction for loss in smelting.

Tonnage of ore, concentrates, and old tailings to amalgamation, cyanidation, and chlorination mills, with quantity of gold and silver contained in bullion and precipitates in Colorado, in 1913, by processes.

Quantity.	Process.	Gold in bullion.	Silver in bullion.
Short tons.		*Fine ounces.*	*Fine ounces.*
.....	Chlorination	7,217.16	41
[a] 696,543	Amalgamation	85,022.11	77,438
[b] 1,303,571	Cyanidation	462,483.08	365,965
Total		554,722.35	443,444

[a] Represent crude ore tonnage, amalgamation in many cases followed by concentration and cyanidation.
[b] Represents crude ore, concentrates, old tailings, and also tailings of ore first treated by amalgamation and concentration.

Consumption of quicksilver and cyanide in Colorado mills in 1913.

Quicksilver.	Potassium cyanide.	Sodium cyanide.
Pounds.	*Pounds.*	*Pounds.*
[a] 10,834	[b] 659,374	[b] 260,589

[a] Represents 1 pound of mercury for every 64 tons of ore and 1 pound of mercury for every 7.85 ounces of gold and 7 ounces of silver.

[b] Potassium and sodium cyanide combined were used at the ratio of 0.71 pound of cyanide per ton of ore or tailings treated and for every pound used there were recovered 0.50 ounce gold and 0.40 ounce silver.

REVIEW BY COUNTIES.

BOULDER COUNTY.

Production of gold, silver, copper, and lead in Boulder County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*		
1904	52	23,905	$388,482	97,228	5,340	.....	$444,815	$18.61
1905	31	9,577	261,601	70,921	2,227	.....	304,784	31.83
1906	44	5,528	188,769	21,923	3,539	47,491	206,847	37.42
1907	38	8,000	161,658	23,480	22,840	16,491	182,597	22.82
1908	38	10,296	147,234	21,498	28,955	96,503	166,503	16.17
1909	56	13,188	163,273	48,183	16,485	425,605	208,772	15.83
1910	85	14,083	139,911	46,517	16,772	53,250	169,503	12.04
1911	115	15,816	163,174	53,753	27,752	145,955	201,700	12.75
1912	126	9,838	119,426	72,335	22,176	305,822	181,333	18.43
1913	121	5,719	69,274	162,384	25,535	409,500	189,330	33.11
Increase (+) or decrease (−)	−5	−4,119	−50,152	+90,049	+3,359	+103,678	+7,997	+14.68

Boulder County in 1913 produced 5,719 tons of ore, yielding $69,274 in gold; silver, valued at $98,080; copper, at $3,958; lead, at $18,018; a total value of $189,330, an increase for 1913 of $7,997. Gold has heretofore been the chief metal product of the county, but for 1913, with a decrease for gold of $50,152, and with an increase for silver of $53,594 in value, silver became first in importance. The lead yield also increased appreciably.

The tonnage of milling ore decreased heavily and the yield of small high-grade lots from pockets, which have always contributed considerable gold, also decreased appreciably. The tonnage of smelting ore decreased from 5,558 tons to 4,614 tons, and the contents of smelting ore showed a decrease of 1,925.84 ounces in gold but an increase of 90,499 ounces of silver and 104,638 pounds of lead.

Central district.—The production of Central district (near Jamestown), was 505 tons, carrying $4,117 in gold, 10,484 ounces of silver, 6,431 pounds of copper, and 221,217 pounds of lead, with a total value of $21,180, as compared with $17,145 in 1912. With the exception of approximately $1,000 in gold from small lots of high-grade gold ore, sold to a small custom chlorination plant at Boulder, all the ore went to smelters. The producing mines were the Argo, Earl, Golden Age, Golden Cross, Golden Harvest, John Jay, Little Ethel,

Maybelle, Overland, Ridgetop, Rip Van Dam, Smuggler, and Tippecanoe.

Gold Hill district.—Formerly the principal producing district in Boulder County, the Gold Hill district fell in 1913 to third place, after Sugar Loaf and Ward districts, with an output of 2,011 tons of ore, yielding $29,231 in gold, 7,828 ounces of silver, 1,316 pounds of copper, and 42,368 pounds of lead, with a total value of $36,027, as compared with $73,434 in 1912. There was a decrease of $29,701 in gold for the year. There were 49 producing mines in 1913, as against 41 in 1912. Mill bullion contained about one-fifth of the gold, and crude ore and concentrates the remainder of the metals produced in the district.

Three mills were operated part of the year and various lots of high gold content were treated by chlorination at Boulder.

The principal producing mines were the Addison, Alice, American, Big Six, Black Swan, Black Cloud, Boston, Cash-Birkin, Clarence, Fairfax, Ingram, Gold Nugget, Little Johnny, Nil Desperandum, Poorman, Prussian, Richmond, Sedom, Snowbound, Temple, and White Rock; and small lots came from 28 other properties.

Grand Island district (Cardinal, Caribou, Eldora, Nederland).—In this district two mines, the Mogul tunnel at Eldora, and the St. Louis, at Caribou, yielded in 1913 several cars of smelting ore carrying chiefly gold.

Magnolia district.—The Magnolia district in 1913 yielded $7,581 in gold and 147 ounces of silver, some lead and copper, with a total value of $7,686, as against $16,625 in 1912. Several small lots of high-grade ore were treated by chlorination at Boulder, and the rest went to smelters. The principal producing mines were the American, Charter Oak, Gold Farm and Little Mabel, Graphic, India, Kansas City, Kekionga, Ophir, Poorman, Sac and Fox, and Valley View.

Sugar Loaf district.—The Sugar Loaf district was the principal producing district in the county in 1913, with an output of 1,434 tons, yielding $14,761 in gold, 93,535 ounces of silver, 11,872 pounds of copper, and 42,292 pounds of lead, with a total value of $74,957, as compared with $32,697 in 1912. The bulk of the ore was shipped to smelters. The free-milling ore of the Logan mine was treated in a small laboratory plant or sold to a custom plant at Boulder; in addition, a good grade of smelting ore was shipped. A small tonnage from the Alpine Horn mine was treated at the Good Luck mill. The U. S. Gold Corporation made a clean-up of gold from tonnage treated in its cyanidation plant in December, 1912. A large tonnage of lead-silver ore was shipped from the Yellow Pine mine. The other principal producing mines were the Copper Glance, Doss, Golden Chest, Lord Byron, Pine Shade, Ragged Top, Ruby, and Slope.

Ward district.—The Ward district in 1913 produced 1,167 tons of ore, yielding $9,984 in gold, 50,271 ounces of silver, 5,874 pounds of copper, and 103,412 pounds of lead, with a total value of $45,808, as against $30,891 in 1912. With the exception of milling ore yielding a few small lots of bullion, all the ore was shipped to smelters. The White Raven was the principal producing mine, with shipments of lead-silver ore. Other producing mines were the Black Jack, Grand View, Idaho, Jolly Six, Lois, Yellow Aster, and the Big Five Co.'s mines.

CHAFFEE COUNTY.

Production of gold, silver, copper, lead, and zinc in Chaffee County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	14	12,777	$69,818	49,874	456,556	458,422	.....	$175,497	$13.74
1905	15	13,408	32,378	75,265	379,722	1,250,302	315,495	214,453	14.87
1906	16	14,134	57,965	54,609	349,466	1,227,019	717,703	275,720	15.97
1907	14	14,592	75,364	38,465	799,505	630,623	2,091,489	417,473	16.47
1908	16	8,772	49,057	35,745	337,804	1,040,238	703,706	189,356	17.68
1909	27	10,214	30,485	35,477	568,868	584,492	947,741	199,197	17.59
1910	26	12,496	77,152	182,003	226,772	970,523	438,539	270,618	20.29
1911	19	7,459	65,714	92,098	88,448	1,001,651	200,509	182,085	23.60
1912	19	10,287	97,489	104,686	133,570	992,578	736,392	279,387	26.71
1913	18	49,135	312,892	168,985	315,011	3,196,545	2,121,947	723,263	14.69
Increase (+) or decrease (−)	−1	+38,848	+215,403	+64,299	+181,441	+2,203,967	+1,385,555	+443,876	−12.02

[a] Includes placer production.

Deep mines in Chaffee County in 1913 produced 49,135 tons of ore, yielding $311,626 in gold; 168,970 ounces of silver, valued at $102,058; 315,011 pounds of copper, valued at $48,827; 3,196,545 pounds of lead, valued at $140,648, and 2,121,947 pounds of zinc, valued at $118,829, with a total value of $721,988, as compared with $274,744 in 1912. Placer mines in 1913 yielded $1,266 in gold and 15 ounces of silver, as compared with $4,619 in gold and 39 ounces of silver in 1912.

There were 16 productive deep mines and 2 placers. The Chalk Creek district yield, valued at five times that of 1912, remained first in point of output, while the yield of Monarch district decreased two-thirds. The yield of the Turret district in copper and zinc remained practically the same.

Chalk Creek district.—Not only were there increased shipments of lead ore from this district, but the Mary Murphy mill, built in 1912–13, was operated the greater part of the year with a heavy yield of lead, iron, and zinc concentrates. The principal mine is the Mary Murphy, the ore of which is a sulphide (in part slightly oxidized) of zinc, lead, iron, and copper, in a gangue of quartz and rhodonite carrying gold and silver. The new mill [1] is a wet-concentration plant with subsidiary amalgamation and electrostatic separation of zinc, iron, and copper. Lead and lead-zinc ore were shipped from the the Black Hawk mine, and dry ore, carrying gold, silver, copper, and lead, from the Colorado Independence mine and from the Iron Chest mine.

Four Mile district.—A small yield of placer gold was made from the Derillo placer on Arkansas River, near Four Mile Creek.

Free Gold district.—A small shipment of gold ore was made from the Marion mine, on the east side of Arkansas River, opposite the town of Buena Vista.

Granite district.—The Twin Lakes Placer Co., with ancient river bed placer ground on Cache Creek, prior to 1911 an important pro-

[1] For description and flow sheet see Parmelee, H. C., Concentration of complex sulphide ore from the Mary Murphy mine. Metall. and Chem. Eng., January, 1914, pp. 21–26.

ducer of placer gold by hydraulicking, having been enjoined in 1911 from polluting the water of Arkansas River, has confined its operations to shoveling gravel into sluice boxes.

Monarch district.[1]—From 10 mines were shipped 4,141 tons, yielding $4,761 in gold, 12,854 ounces of silver, 59,737 pounds of copper, 330,766 pounds of lead, and 283,008 pounds of zinc, with a total value of $52,186, as compared with $116,292 in 1912.

The Madonna mine was again the chief producer,[2] but with decreased shipments of lead carbonate and zinc carbonate ores. Lead oxidized ore carrying gold, silver, and lead, was shipped from the Garfield mine. Copper oxidized ore was shipped from the Lilly mine.[3] Lead oxidized and zinc oxidized ores were shipped from the Giant-Eclipse mine, dry gold and silver ore from the Jasper, lead oxidized ore from the Moose, lead oxidized ore from the Rainbow, copper ore from the Shamrock, and dry, lead, and zinc ore from the Hawkeye mine.

Riverside district.—Dry sulphide and lead sulphide ores carrying gold, silver, copper, and lead were shipped from the Mount Harvard mine.

Turret district (including Sedalia).—Zinc sulphide, copper oxidized, and copper sulphide ores were shipped from the Sedalia mine.

CLEAR CREEK COUNTY.[4]

Production of gold, silver, copper, lead, and zinc in Clear Creek County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average total value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	53	62,661	$665,459	735,985	369,778	3,753,447	2,135,302	$1,404,010	$22.37
1905	49	58,775	503,698	692,437	235,669	3,270,211	1,869,995	1,222,724	20.77
1906	71	64,774	529,753	652,796	235,375	3,307,001	1,755,805	1,308,156	20.14
1907	88	79,548	522,896	518,364	171,340	2,804,172	1,406,187	1,130,870	14.07
1908	104	109,672	659,116	503,551	264,994	2,015,010	836,411	1,084,918	9.87
1909	150	116,753	536,407	448,535	299,546	3,254,675	758,074	989,473	8.44
1910	157	109,954	522,524	475,174	595,795	2,434,476	1,247,389	1,029,260	9.33
1911	95	105,774	519,207	437,841	650,368	3,325,222	1,417,544	1,062,994	10.03
1912	91	102,892	445,794	373,940	449,401	3,523,733	1,734,493	1,028,166	9.99
1913	105	104,892	432,489	408,527	426,393	3,999,614	1,489,518	1,004,726	9.58
Increase (+) or decrease (−)	+ 14	+ 1,998	−13,305	+34,587	−23,008	+475,881	−244,975	−23,440	−0.41

[a] Includes placer production.

The total yield of Clear Creek County in 1913 was $432,489 in gold; silver, valued at $246,750; copper, $66,091; lead, $175,983; zinc, $83,413—a total value of $1,004,726. The output of gold-silver bullion and cyanide precipitates decreased, but there was a small increase in gold and silver content in crude ore and concentrates.

[1] For discussion of the geology of the district see Crawford, R. D., Geology and ore deposits of the Monarch and Tomichi districts, Colorado: Colorado State Geol. Survey Bull. 4, 1913.

[2] For the total output of mine, including 1911, see Crawford, R. D., op. cit., p. 239.

[3] Crawford, R. D., op. cit., p. 262.

[4] For discussion of geology see Spurr, J. E., and Garrey, G. H., Preliminary report on the ore deposits of the Georgetown mining district, Colorado: U. S. Geol. Survey Bull. 260, pp. 99–120, 1905; the Idaho Springs mining district, Colorado: U. S. Geol. Survey Bull. 285, pp. 35–40, 1906; Economic geology of the Georgetown quadrangle (together with the Empire district), Colorado, with general geology by S. H. Ball: U. S. Geol. Survey Prof. Paper 63, 422 pp., 1906.

The copper yield varied little. The content of lead in both crude ore and concentrates increased somewhat. The zinc yield was chiefly from concentrates, with a decrease of content for 1913.

The output from the Lower Clear Creek mines (Idaho Springs, Cascade, Jackson, Montana, and Trail districts combined) showed an increase in tonnage, an increase for silver, copper, and lead, a decrease for gold and zinc, but an increase in combined values; while Upper Clear Creek mines (Argentine, Empire, and Griffith districts) showed a decrease in tonnage and quantity of all the metals.

There were 105 producing deep mines or groups of mines, as compared with 88 in 1912. The quantity of ore sold or treated was 104,892 short tons, as compared with 102,894 tons in 1912.

Alice (or Yankee) district.—The output of the Alice district was $1,884, mostly gold, as compared with $2,112 in 1912. A small tonnage from the Clara mine and from the Silver Glance mine was treated at the Clara amalgamation mill. A small tonnage from the Reynolds Bros. mine was treated by amalgamation. A small tonnage of smelting ore was shipped from the district.

Argentine district.—The Argentine district, from 6 mines, produced 2,134 tons, yielding $18,123 in gold, 34,194 ounces of silver, 62,156 pounds of copper, 671,471 pounds of lead, and 22,731 pounds of zinc, with a total value of $79,228, as compared with $88,311 in 1912.

The Santiago, Josephine, and Waldorf mines were the principal producers, with output in smelting ore, carrying gold, silver, copper, lead, and some zinc. A small lot from the Kitty Owsley mine was concentrated, and a small quantity of lead sulphide and lead-zinc sulphide was shipped. Small shipments were made from the McClellan Mountain and Mary Etta mines.

Empire (or Upper Union) district.—The Empire district in 1913, from 6 mines, produced 3,356 tons, yielding $22,302 in gold, 5,834 ounces of silver, 8,831 pounds of copper, and 34,083 pounds of lead, with a total value of $28,695, as compared with $30,670 in 1912. More than 90 per cent of the tonnage was treated by amalgamation and concentration. Concentrates and crude ore to smelters contained 87 per cent of the gold, nearly all the silver, and all the lead and copper produced in the district. Lead ore was shipped from the Bard Creek mines and from the Duluth and Empire mines. Gold ore from the Gold Dirt and Gold Fissure mines was milled at Idaho Springs and shipped to smelters. A considerable tonnage from the Pioneer mine was treated by amalgamation and concentration. Lead ore was shipped from the Bellevue-Hudson and Animosa mines.

Georgetown (Griffith, Silver Plume) district.—The Georgetown district in 1913 from 14 mines produced 38,875 tons of ore, yielding $54,221 in gold, 114,883 ounces of silver, 42,715 pounds of copper, 1,324,366 pounds of lead, and 1,405,883 pounds of zinc, with a total value for the five metals of $267,232, as compared with $354,922 in 1912. The output of ore in 1913 was 5,554 tons less than in 1912. The gold production decreased $28,325, there being decreases in quantity of bullion, concentrates, and crude ore shipped to smelter. The output of all the other metals also decreased. Zinc production from this district represented 94 per cent of the county yield.

The tonnage from the Capital mine was not equal to the output in 1912 and the 260-ton amalgamation-concentration mill was not operated at capacity, but considerable development work was done, including a 700-foot raise above tunnel level for ventilation. Crude

ore was shipped to smelters and dump and mine ore from the Dives-Pelican-Seven-Thirty group and other properties was treated at the Burleigh and at the Scotia mill, the output being lead and zinc concentrates. Lead sulphide ore was shipped to smelters and lead-zinc sulphide ore was sent to mills from the Smuggler mine. Lead-zinc ore from the Mendota-Frostburg mine was treated at the Mendota concentration mill, the product being lead concentrates, zinc concentrates, and a zinc-iron middling. Lead-silver sulphide ore was shipped from the East Griffith mine. Small lots of smelting ore were shipped from various other properties.

Idaho Springs district.—In the Idaho Springs district are included the mines about Idaho Springs, including Banner, Cascade, Coral, Jackson, Lower Fall River, Payne's Bar, Spanish Bar, and Virginia subdistricts.

In 1913 there were 53,419 tons of ore mined in the Idaho Springs district, as compared with 46,074 tons in 1912. The production of metals in 1913 was $282,603 in gold, 214,481 ounces of silver, 309,885 pounds of copper, 1,628,324 pounds of lead, and 4,639 pounds of zinc, with a total value for the five metals of $532,088, as compared with $440,639 in 1912.

In 1913, of the 53,419 tons mined, 27,095 tons were treated at amalgamation, cyanidation, and concentration mills, and 14,371 tons were treated at mills for concentration only, a total to both classes of mills of 41,466 tons, yielding 5,166 tons of concentrates (ratio 8 to 1). These concentrates and 11,953 tons of crude ore, 17,119 tons in all, were shipped to smelters, and contained all the metals produced by the mines in the district (with the exception of 1,297.27 fine ounces of gold, valued at $26,817, and 2,242 ounces of silver, valued at $1,354, in amalgamation bullion and cyanide precipitates).

Through the Big Five Tunnel, ore from the East and West Belman, Lake, and Shafter mines was shipped to smelters or to various custom amalgamation, cyanidation, and concentration mills. Ore from the upper levels of the Specie Payment mine was sent to Black Hawk mills, but the bulk of the ore was taken out through the Two Brothers Tunnel and sent to custom plants at Idaho Springs or to smelters. In Virginia Canyon, the Bald Eagle, Crystal, Mona, Papoose, Treasure Vault, and Victor mines were producers. Through the Newhouse Tunnel, the principal producing property was the Gem Consolidated mines, from which a heavily increased tonnage was sent to mills and smelters. An appreciable tonnage was mined from the Golden Edge mine at tunnel level. A considerable tonnage of ore from mines in Gilpin County was trammed through the Newhouse Tunnel and sold or treated at Idaho Springs. The recovered metals from this ore are accredited to Gilpin County. At the mouth of the Newhouse Tunnel, the Argo [1] 20-stamp amalgamation, concentration, and cyanidation custom mill was operated from May to December. In the latter part of the year amalgamation was discarded. Ore from the Franklin, French Flag, and Freeman mines, in Gilson Gulch, was shipped to mills and smelters. An appreciable tonnage from the Seaton and Seven-Twenty mines was shipped to mills and smelter. Lead and some lead-zinc ore from the Bride mine (worked through the Idaho Tunnel) was milled at the Gem mill, and crude lead ore,

[1] For description see U. S. Geol. Survey Mineral Resources, 1912, pt. 1, p. 653, 1913; Eng. and Min. Jour., Aug. 30, 1913, pp. 385-389; and Colorado State Bur. Mines Twelfth Bienn. Rept., 1911-12, p. 80, 1913; see also Roller, A. H., and Curran, H. T., Ore treatment at the Argo mill; Eng. and Min. Jour., July 1, 1914, p. 1.

lead and iron concentrates, and a small tonnage of zinc concentrates, were sent to smelters. On the south side of Clear Creek the Little Mattie mine was an important producer, with an increased tonnage both to the company's mills and to smelters. A small tonnage from the Gladstone mine was concentrated or sent to smelters. Only a small tonnage was mined from the Stanley mines. The Hoosac mine and new mill were operated for a short time. Several lots were shipped from the Almaden mine on Fall River.

In the Jackson and Cascade districts producing mines were the Black Eagle, Chicago Mountain, Dorit, Humboldt, and P. T.

Montana (Dumont and Lawson) district.—The Montana district in 1913, from 10 mines, produced 971 tons, carrying $1,330 in gold, 22,919 ounces of silver, 76 pounds of copper, and 175,188 pounds of lead, with a total value of $22,893, as against $18,754 in 1912. The principal producing mine was the Blue Ridge, the output being lead ore to smelters and dry concentrates carrying lead, silver, and some gold from the concentration plant on the property. Smelting ore was shipped from the Commodore, Millington, and Plattz mines.

Trail Creek (Lamartine and Freeland) district.—The Trail Creek district in 1913, from 7 mines, produced 5,845 tons, yielding $52,201 in gold, 15,952 ounces of silver, 2,730 pounds of copper, 165,815 pounds of lead, and 56,265 pounds of zinc, with a total value of $72,706, as against $92,427 in 1912. Lead-zinc ore from the Ben Harrison mine was concentrated at the Newton mill, yielding lead and lead-zinc concentrates. Milling and smelting ores were shipped from the Lamartine-Money Musk group. The output of both milling and smelting ore from the Centurion-Rockford and other properties of the North American Smelter & Mines Co. decreased heavily. Ore from the Oneida mine was sent to custom mills or to smelters. The tonnage from the New Era mine was treated at its mill and crude ore shipped to smelters increased.

CONEJOS-RIO GRANDE COUNTIES.

Platora-Gilmore-Summit district.[1]—Prospecting and some development work was done in the reopening of this district, which is 45 miles southwest of Monte Vista, near the Rio Grande-Conejos County line. A ton test lot of ore was shipped by the Gaudaloupe Co. of Platora and 200 pounds from the Smuggler claim, near Stunner, was tested at the Woods testing plant, at Denver.

COSTILLA COUNTY.

Grayback district.[2]—A small quantity of gold was recovered by sluicing in the district.

CUSTER COUNTY.[3]

From 7 mines in Custer County in 1913 there were sold or treated 4,662 tons of ore, from which were recovered $14,648 in gold, 11,313

[1] For discussion of the geology of the district see Hills, R. C., Ore deposits of the Summit district, Rio Grande County, Colo.: Colorado Sci. Soc. Proc., vol. 1, pp. 20–36, 1883. Raymond, R. W., Mines and mining west of the Rocky Mountains, vol. 10, p. 329, 1875. Emmons, W. H., The enrichment of sulphide ores: U. S. Geol. Survey Bull. No. 529, p. 226, 1913.

[2] For discussion of geology see Patton, Smith, Butler, and Hoskins, Geology of the Grayback mining district, Costilla County, Colo.: Colorado State Geol. Survey Bull. for 1909, No. 2, 1910.

[3] For discussion of geology see Cross, Whitman, Geology of Silver Cliff and the Rosita Hills, Colorado: U. S. Geol. Survey Seventeenth Ann. Rept., pt. 2, pp. 263–403, 1896, and Emmons, S. F., The mines of Custer County: Idem, pp. 405–472.

ounces of silver, valued at $6,833; 4,052 pounds of copper, valued at $628; and 5,273 pounds of lead, valued at $232, with a total value of $22,377, as compared with $33,336 in 1912. The yield of all the metals except copper decreased. The greater part of the ore was treated by cyanidation and the remainder was shipped to smelters.

Dump ore from the Bassick mine was treated in the 35-ton cyanide plant at Ilse. Smelting ore was shipped from the Bismuth, Delaware, Delia, King of the Carbonates, and Twenty-Six mines at Westcliffe.

The Terrible mine [1] near Ilse, was unwatered during 1913, but no output was made.

DOLORES COUNTY.

Production of gold, silver, copper, lead, and zinc in Dolores County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average total value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904.....	10	7,727	$41,391	100,194	12,201	260,584	145,060	$118,928	$15.39
1905.....	5	3,826	34,766	76,526	119,821	840,319	1,500,000	227,675	59.51
1906.....	8	2,242	9,398	34,290	199,379	118,229	22,506	78,964	35.22
1907.....	8	1,575	11,689	33,037	99,495	54,547	12,649	57,029	36.21
1908.....	5	11,024	37,238	163,563	42,495	947,962	509,184	193,281	17.53
1909.....	10	4,787	22,266	103,646	43,538	462,373	167,574	110,753	23.14
1910.....	13	2,933	15,327	88,309	97,063	127,909	87,000	85,667	29.21
1911.....	12	3,276	7,565	56,202	3,288	701,244	525,333	99,263	30.30
1912.....	7	8,485	7,556	100,288	689,915	1,212,400	812,029	293,658	34.60
1913.....	8	17,802	12,432	178,816	801,819	3,079,341	2,596,232	525,599	29.52
Increase (+) or decrease (−).....	+1	+9,317	+4,876	+78,528	+111,904	+1,866,941	+1,784,203	+231,941	−5.08

Dolores County in 1913 produced 17,802 short tons of ore, yielding $12,432 in gold; silver, valued at $108,005; copper, at $124,282; lead, at $135,491; and zinc, at $145,389, with a total value of $525,599, as compared with $293,658 in 1912.

Lone Cone (Dunton) district.—The Emma mine continued to be the only important producer in the Lone Cone district. The ore from this mine carries chiefly gold and silver; the greater part was concentrated in the company's mill, the remainder being shipped to smelters. A small tonnage of ore carrying silver and copper was shipped from the Rosebud mine and from the Liberty Trust mine.

Pioneer (Rico[2]) district.—This district in 1913 produced 17,272 tons, yielding $6,332 in gold, 153,111 ounces of silver, 800,375 pounds of copper, 3,075,745 pounds of lead, and 2,596,232 pounds of zinc, with a total value of $503,591, as compared with $267,702 in 1912. The ore was lead, lead-zinc, copper, and iron; part of the lead-zinc ore was concentrated at Rico, and part was shipped to Coffeyville, Kans.; the lead and copper ore went to smelters near Salt Lake City, and some to Durango, Pueblo, and Salida; and the iron ore was shipped to Vanadium, for use in the treatment of vanadium

[1] For discussion of geology see Hunter, J. F., Some cerusite deposits in Custer County, Colo.: U. S. Geol. Survey Bull. 580, pp. 25–37, 1914.

[2] For discussion of geology see Ransome, F. L., The ore deposits of the Rico Mountains, Colorado, U. S. Geol. Survey, Twenty-second Ann. Rept., pt. 2, pp. 229–398, 1901.

ores. The Rico-Wellington group was the principal producing property. The public report of this company states:

The remodeling of the Pro Patria mill, on which we have a five-year lease, and started during 1912, was completed during the early part of 1913 * * *; 5,178 tons of lead-zinc ore have been milled * * *. We have made into concentrate sand middlings (including 270 tons of middlings) over 92 per cent of the product sent to the mill. Ore production, lead ore, 786 dry tons, $19.09 per ton; copper ore, 4,804 dry tons, $9.73 per ton; lead concentrates, $36.20 per ton; zinc concentrates, $13.22 per ton; zinc middlings, $8.88 per ton.

Lessees (including the Rico Argentine Co.) on the Rico Mining Co.'s group also produced a large tonnage of ore of various classes. Some iron ore was shipped to Vanadium, Colo., for use in the treatment of vanadium ores.[1] Other producing mines were the Sambo, David M., South Park, and Lucky Boy.

DOUGLAS COUNTY.

A small quantity of placer gold was recovered by sluicing in Newlins Gulch, near Parker, in Douglas County, in 1913.

EAGLE COUNTY.

Production of gold, silver, copper, lead, and zinc in Eagle County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver..[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	10	1,866	$30,460	21,011	27,042	323,969	3,080	$60,195	$32.26
1905	9	12,049	46,891	46,487	29,331	156,723	2,915,025	258,897	21.47
1906	16	15,986	51,561	94,912	130,233	307,755	1,065,082	222,799	13.94
1907	15	4,191	53,641	70,586	14,270	193,690	507,949	143,317	34.20
1908	10	3,009	58,131	86,715	66,141	11,204	.....	113,292	37.62
1909	16	11,526	53,308	125,214	286,885	152,280	740,408	202,244	17.45
1910	18	27,761	25,231	88,313	209,551	397,409	4,147,945	341,008	12.27
1911	11	33,177	43,160	116,109	66,608	855,889	5,097,597	440,102	13.26
1912	19	34,164	49,294	163,735	147,176	1,240,156	5,659,261	620,571	18.16
1913	29	47,488	41,220	301,380	41,368	1,351,205	6,683,643	663,403	13.97
Increase (+) or decrease (−)	+19	+13,324	−8,074	+137,645	−105,808	+111,049	+1,024,382	+42,832	−5.19

[a] Includes placer production.

Eagle County in 1913 produced 47,488 tons of ore, yielding $41,220 in gold; silver, valued at $182,034; copper, at $6,412; lead, at $59,453; zinc, at $374,284—a total value of $663,403, as compared with $620,571 in 1912. The yield of silver for the county increased 137,645 ounces, owing to the output of the new silver district at Eagle; the yield of zinc increased 1,024,382 pounds. The county maintained its place as third in the production of zinc, almost equaling Summit County's zinc yield. There were 29 producing deep mines, as against 19 producing mines, 1 of which was placer, in 1912. Both the tonnage shipped to separating mills and to smelters increased.

Battle Mountain district.—With an increase in the capacity of the magnetic separation mill from 80 tons to 120 tons per day in 1912, an increased tonnage of lead-zinc sulphide ore was mined and milled

[1] For discussion of treatment of vanadium ores see Moore, R. B., and Kithil, K. L., A preliminary report on uranium, and vanadium: Bur. Mines, Bull. 70, p. 74, 1914.

in 1913 from the Iron Mask group. The output was zinc, lead, and iron concentrates. The crude ore milled carries about as follows: 1 to 5 per cent lead, 17 per cent zinc, 30 per cent iron, 26 per cent sulphur, and 2 per cent silica.[a] Some lead oxidized ore was also shipped in 1913. Lessees on the Champion and Ground Hog mines shipped dry gold-silver sulphide, lead sulphide, and copper sulphide ores. Lead sulphide ore, dry silver ore, and lead-zinc sulphide ore were shipped from the Wilkesbarre mine by lessees. Other mines of importance from which ore was shipped were the Bleak House, Foster Combination, and Alleghany mines. Pine Martin, Star of the West, and Tip Top.

Eagle or Brush Creek district.—From this new district, on Brush Creek, a considerable tonnage of silver ore was shipped to smelters from the Lady Belle and North Dakota mines.

Girard Mountain district.—A small tonnage of copper ore was shipped from the Black Tiger and from the California mine.

Holy Cross district.—Small lots of gold-silver ore of good grade were shipped from the Alaska, Gold Bug, and Spread Eagle mines.

Mount Egley district.—A small tonnage of gold-silver ore of good grade was shipped from the Ohio mine.

EL PASO COUNTY.

Blair Athol district.—From a surface deposit of copper oxidized ore in sandstone at Blair Athol, about 6 miles north of Colorado City, several cars of ore and concentrates (made with the Hardwick hydraulic concentrator) were shipped.

FREMONT COUNTY.

A small tonnage of lead-zinc ore from the Gumaer mine at Cotopaxi was shipped to Denver, and of copper ore from the Farrell mine at Parkdale was shipped to Omaha.

GARFIELD COUNTY.

A small tonnage of gold-silver ore, carrying a good commercial content of gold, was shipped from the Gray Eagle mine, near Newcastle.

GILPIN COUNTY.

Production of gold, silver, copper, lead, and zinc in Gilpin County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.[b]	Silver.[b]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	55	109,557	$1,104,823	355,354	604,791	125,731	113,000	$1,395,023	$12.73
1905	66	182,873	1,450,033	340,901	512,276	519,841	191,574	1,771,588	9.69
1906	90	114,662	1,115,902	242,478	638,092	540,791	.....	1,430,611	12.48
1907	84	87,887	998,485	209,347	874,960	611,060	.....	1,282,855	14.58
1908	112	120,761	1,055,808	187,090	636,371	538,143	.....	1,281,537	10.61
1909	244	111,118	887,311	172,010	499,146	664,581	.....	1,070,222	9.63
1910	162	83,631	687,902	132,635	544,244	575,477	.....	852,695	10.19
1911	192	103,038	778,774	292,659	950,240	1,239,356	23,688	1,100,750	10.77
1912	151	118,652	904,505	316,205	1,025,770	1,351,600	25,377	1,330,796	11.22
1913	122	94,156	687,101	279,267	857,974	1,220,341	8,589	1,035,747	11.00
Decrease(–)	–29	–24,496	–217,404	–42,998	–187,796	–141,259	–16,788	–295,056	–0.22

[a] Hanington, C. H., Colorado State Bur. Mines, Twelfth Bienn. Rept., 1911-12, p. 73, 1913.
[b] Includes placer production.

Gilpin County in 1913 produced 94,156 short tons of ore against 118,652 tons in 1912. There were 70 companies or individuals operating deep mines or groups of mines, and there were 50 small lots of ore produced from other properties, making a total of 120 mines from which ore was derived, as against 151 in 1912. In 1913 there were 2 producing placer mines.

The yield of gold was $687,101; the silver yield was valued at $165,017; copper, $129,886; lead, $53,255; and zinc, $481—a total value of $1,035,740, as against $1,330,796 in 1912. The tonnage sent to amalgamation and concentration mills in Gilpin County (and to amalgamation, cyanidation, and concentration mills at Idaho Springs) decreased materially, with a consequent decrease in gold-silver bullion and precipitates. The tonnage to mills for concentration only and the resulting concentrates produced decreased heavily. The tonnage of crude ore to smelters increased slightly, but the contents decreased appreciably.

The Polar Star and U. P. R. custom amalgamation-concentration mills were operated less continuously than in 1912; the Frontenac concentration mill was operated steadily on Frontenac ore until that mine closed on company account in October; the Iron City concentration mill was operated on custom ore, and the Smith mill was operated on crude and dump ore.

Almost all the ore of Gilpin County is dry siliceous, there being some ore carrying copper above 2½ per cent and a small tonnage of ore carrying lead above 4½ per cent. Concentrating ore in 1913 made practically all dry concentrates, there being some lead concentrates produced and a few cars of zinc concentrates.

Southern area (Central City, Black Hawk, Nevadaville, Russell Gulch).—The old districts of the main area of Gilpin County are so indefinite that separation of output by districts has been abandoned.

In the immediate vicinity of Central City, producing mines were the Bonanza, Corydon, East Boston, Huddleston, and Troublesome.

In the Enterprise district, below Black Hawk, producing mines were the Coaley, Galena, Little Kingdom, and Mohaska.

Producing mines in the district embracing Gunnell Hill and Eureka and Prosser gulches, were the Buckley, Eureka, and Gunnell group.

Producing mines in the district embracing the town of Black Hawk and the Gregory, Bobtail, and Bates hills were the After Supper, Americus, Bates, Dump Lode, Fisk, Gilpin-Orion, Nemeha, O. K., Running Lode, Senator, U. P. R., and Whitesides.

Producing mines in the district embracing Illinois and Leavenworth gulches and the east portion of Quartz Hill were the Alps, Bezant, East and West Calhoun, Egyptian, Ethan Allen, German & Belcher, and Wood. In this district, pitchblende has been mined from time to time at the Wood, Kirk, Alps, Calhoun, and German & Belcher mines.

Producing mines in the Lake Gulch district were the Pittsburg, Pittsburg Extension, New National Tunnel group, Success, and West Notaway.

In the vicinity of Nevadaville, among producing mines were the Barnes, Belden, Columbia, Divernon, Centennial, Dyke, Edinburg, Hubert, Ralls County, San Juan, Shanks tunnel, and West Baker. The Dyke mine was worked from the Newhouse tunnel level and the ore was shipped to Idaho Springs, but the contents have been credited

to Gilpin County. Some zinc concentrates were recovered from the milling of ore from the Hubert mine.

In the Quartz Valley district, producing mines were the Castle Rock, Buckeye, and Margaret Glennon.

The Russell Gulch district is the most important in Gilpin County. Among producing mines were the Bosom Plume, Chase, Denbigh, Druid, Federal, Frontenac, Gem, Ipava, King Bee, Old Town group, Richardson, Rockford, Silver Dollar, Square Deal (East Notoway), Topeka, Two Forty, and War Dance.

Northern districts.—The outlying districts in Gilpin County are the Vermilion district, 4 miles northwest of Central City; Pine district, 7 miles northwest of Central City; Independence and Union districts, 9 miles north of Central City, embracing Perigo and Rollinsville, Lump Gulch, and Moon Gulch sections; Phoenix district, along the North edge of the county, near the Boulder County line; and Silver Lake district, 5 miles north of Central City.

Independence, Union, and Phoenix districts.—The principal mines in the outside districts were near Perigo and Rollinsville. There were 1,447 tons of ore from these districts sold or treated in 1913. The yield of both deep and placer mines had a total value of $12,660, of which $11,568 was gold. Nearly all the ore was milled. Ore from the Smuggler mine was treated by amalgamation and concentration, and a small tonnage from the Golden Flint mine was treated by amalgamation. A new 100-ton amalgamation and cyanidation mill was erected at the Golden Flint mine. A small yield of placer gold was made near Perigo. A shipment of ore was made from the Lone Star mine, in the Phoenix district.

Pine (or Wisconsin) district.—A 10-stamp, 50-ton amalgamation-concentration mill was built at the London mine in 1913.

GUNNISON COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Gunnison County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	15	2,067	$28,720	128,096	1,864	19,820	.....	$103,155	$49.58
1905	18	5,581	28,156	53,649	50,500	219,809	101,559	84,761	15.19
1906	20	31,103	87,505	70,798	.....	248,737	328,180	169,137	5.44
1907	17	18,078	61,569	27,277	13,690	120,226	68,644	92,732	5.13
1908	16	14,439	100,032	28,664	5,481	327,612	147,000	136,617	9.46
1909	18	9,071	108,493	37,423	51,815	493,070	212,093	167,344	18.45
1910	14	25,203	233,972	49,189	21,024	581,841	176,815	298,353	11.84
1911	20	11,926	145,039	32,541	9,928	631,933	557,456	223,739	18.65
1912	14	14,046	125,327	29,035	8,097	306,867	483,884	191,717	13.60
1913	19	4,301	10,189	87,488	21,864	196,728	292,875	91,478	21.13
Increase (+) or decrease (−).	+ 5	− 9,745	−115,138	+ 58,453	+13,767	−110,139	−191,009	−100,239	+ 7.53

[a] Includes placer production.

The output from Gunnison County in 1913, from deep and placer mines, was $10,189 in gold; the silver yield was valued at $52,843; copper, $3,389; lead, $8,656; zinc, $16,401—a total value of $91,478,

as compared with $191,717 in 1912. Owing to the closing of the Gold Links mine at Ohio City, the output of gold decreased heavily. The silver output increased because of the opening of mines on Italian Mountain, near Crested Butte, and at Pitkin.

Box Canyon district (*Waunita Hot Springs*).—There was no output from the Box Canyon district.

Cochetopa district (*Sillsville*).—The Maple Leaf mine was idle.

Gold Brick district (*Ohio*).—For many years this has been the most important producing district in Gunnison County, but in 1913, with the closing of the Gold Links mine, the yield fell off heavily. The producing mines in 1913 were the Belzora-Bassick, Raymond, and Sandy Hook.

Italian Mountain district (*Crested Butte*).—A considerable tonnage of lead-silver ore was shipped from the Independent mine, on Italian Mountain.

Quartz Creek district (*Pitkin*).—The Quartz Creek district was the most important producing district in Gunnison County in 1913. Shipping ore from 7 mines amounted to 1,902 tons, carrying $3,402 in gold, 47,153 ounces of silver, 1,435 pounds of copper, and 31,587 pounds of lead, with a total value of $33,494. Producing mines mere the Bon Ton, Citizen, Emma H., L. C., Maid of Athens, and Red Jacket.

Rock Creek district (*Marble*).—Lead-zinc ore from the Lead King mine was shipped to the Leadville district mill, Leadville, and to the Sutton, Steele & Steele mill, Denver.

Tin Cup district.—Small lots of lead ore were shipped from the Gold Cup and Black Diamond mines. The dredge installed in 1913 near Tincup was operated for several days, with a small yield of gold.

Tomichi district (*Whitepine*).[1]—Several cars of lead-zinc ore were shipped to Leadville for concentration from the Erie mine. Several cars of lead and lead-zinc ores were shipped to smelters from the Morning Star mine. Copper-lead ore was shipped from the Spar mine.

HINSDALE COUNTY.[2]

Production of gold, silver, copper, lead, and zinc in Hinsdale County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	11	5,591	$7,692	39,283	10,530	1,054,421	101,086	$82,679	$14.79
1905	10	5,041	11,991	54,419	84,485	767,681	2,085	94,244	18.70
1906	16	7,086	24,510	87,940	63,621	753,950	30,475	140,543	19.83
1907	9	10,740	7,520	50,109	99,410	1,204,628	23,034	125,678	11.70
1908	10	980	2,454	29,498	188,698	280,465	.....	54,776	55.89
1909	10	1,697	7,587	75,731	714,569	106,327	.....	144,433	85.11
1910	12	3,468	6,320	54,422	465,472	296,182	.....	107,855	31.10
1911	6	723	3,830	7,753	21,696	118,645	36,439	18,067	24.98
1912	12	9,554	6,811	34,722	53,739	1,257,800	11,926	94,456	9.89
1913	14	4,329	5,280	30,477	76,304	782,318	54,732	73,002	16.86
Increase (+) or decrease (−).	+2	−5,225	−1,531	−4,245	+22,565	−475,482	+42,806	−21,454	+6.97

[1] For discussion of geology see Crawford, R. D., Geology and ore deposits of the Monarch and Tomichi districts, Colo.: Colorado Geol. Survey Bull. 4, 1913.

[2] For discussion of geology see Irving, J. D., Ore deposits in the vicinity of Lake City, Colo.: U. S. Geol. Survey Bull 260, pp. 78–84, 1905; Ore deposits of the Ouray district, Colo.: U. S. Geol. Survey Bull. 260, pp. 50–77, 1905. Irving, J. D., and Bancroft, Howland, Geology and ore deposits near Lake City, Colo.: U. S. Geol. Survey Bull. 478, 128 pp., 1911. Larsen, E. S., The economic geology of Carson Camp, Hinsdale County, Colo.: U. S. Geol. Survey Bull. 470, pp. 30–38, 1911

Hinsdale County in 1913, from 14 mines, produced 4,329 tons of ore, yielding $5,280 in gold; silver, valued at $18,408; copper, $11,827; lead, $34,422; and zinc, $3,065, a total of $73,002, as compared with $94,456 in 1912.

Galena district.—Most of the active mines in Hinsdale County are in the Galena district. From the Ajax and Moro, Czar, Hidden Treasure, and Highland Chief mines lead and lead-zinc ores were sent both to concentration plants and to smelters. Crude ore to smelters was shipped from the Bonanza, Dolly Varden, Frank Hough, and Independence mines.

Lake district.—A considerably increased tonnage of smelting ore was shipped from the Lake district from the Black Crook, Golden Wonder, and Pelican mines. The ore shipped included lead, zinc, copper, and dry ores.

LAKE COUNTY.

Production of gold, silver, copper, lead, and zinc in Lake County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	66	663,487	$1,175,841	4,820,596	3,627,846	54,392,821	92,005,179	$11,369,059	$17.14
1905	61	648,464	1,180,401	4,033,762	3,105,710	51,162,040	64,856,033	10,332,406	15.93
1906	61	672,055	1,509,381	3,890,338	2,092,735	47,456,964	71,702,721	11,598,718	17.26
1907	70	631,273	1,064,690	4,154,913	2,679,510	32,519,796	37,412,374	8,273,714	13.10
1908	61	408,711	1,228,449	2,893,496	4,674,502	19,646,007	23,188,080	5,294,008	12.95
1909	97	417,297	1,435,431	3,423,642	5,182,608	21,073,992	38,637,315	6,882,061	16.49
1910	105	462,033	1,213,134	3,322,015	3,645,157	19,249,503	56,367,445	7,360,777	15.92
1911	94	438,419	1,133,442	3,007,296	4,017,504	18,499,089	71,610,456	8,143,752	18.58
1912	100	507,591	1,103,230	3,000,397	2,065,800	26,234,244	105,945,783	11,780,131	23.21
1913	91	528,311	1,023,631	3,400,318	1,923,987	29,286,183	93,842,857	9,919,433	18.78
Increase (+) or decrease (−)	−9	+20,720	−79,599	+399,921	−141,813	+3,051,939	−12,102,926	−1,860,698	−4.43

[a] Includes placer production.

In 1913 the value of the yield of Lake County, because of the decreased production of zinc and the lower price, dropped again below the values of the Cripple Creek output, which had been surpassed in 1912. Teller, Lake, and San Miguel remained the order of counties in point of tonnage shipped or treated. The Lake County tonnage was 19 per cent and the value 28 per cent of the respective State totals. This county was again first in the production of silver, copper, lead, and zinc; and in the production of gold it followed Teller and San Miguel, holding third place, which was taken from Ouray County in 1912.

Of the State total, Lake County, produced 36 per cent of the silver, 33 per cent of the lead, 27 per cent of the copper, and 79 per cent of the zinc.

In 1913, from 91 deep mines, there were sold or treated 528,311 tons, as against 507,591 in 1912. The gold production was $1,023,631; the silver yield was valued at $2,053,792; copper, $298,218; lead $1,288,592; zinc, $5,255,200; a total value of $9,919,433.

Lake County includes the Leadville, St. Kevin or Sugar Loaf, Twin Lakes, Lackawanna Gulch, and Big English Gulch districts.

Leadville (California) district.[a]—Of a total of 528,311 tons of ore mined in this county, 514,600 tons were from the Leadville district. The tonnage from this district yielded $929,206 in gold, 3,160,816 ounces of silver, 1,906,465 pounds of copper, 29,095,295 pounds of lead, and 93,842,857 pounds of zinc, with a total value of $9,669,234, out of a county total of $9,919,433.

As compared with 1912, this output shows a small increase in tonnage, a decrease of $165,961 in gold and of 12,102,926 pounds of zinc, but an increase of 355,387 ounces of silver and of 2,946,895 pounds of lead.

The output of zinc-carbonate ore decreased from 142,782 tons of 29.2 per cent zinc in 1912 to 135,760 tons of 27.45 per cent zinc in 1913. The zinc-sulphide ore sold or treated at Leadville decreased from 104,148 tons of 24 per cent zinc in 1912 to 97,704 tons of 23 per cent in 1913.

CLASSIFICATION OF LEADVILLE ORES.

The following table shows the classification of Leadville ores:

Classification of Leadville ores.

Character.	Quantity.	Quantity.	Percentage.
Sulphide:	*Short tons.*	*Short tons.*	
Zinc-iron-lead (zinc blende: Pyrite with a little galena)	97,704	97,704	19.0
Iron (pyrite with a little copper, gold, silver, and lead)	152,223	163,214	31.7
Iron (pyrite with a little copper, gold, silver, and lead over 4½ per cent lead).	10,991		
Total sulphide	260,918	260,918	50.7
Oxide:			
Lead	32,153	32,217	6.3
Copper	64		
Iron and iron-manganese (silver, and some lead)	61,389	61,389	11.9
Zinc carbonate and silicate	135,760	135,760	26.4
Total oxide	229,366	229,366	44.6
Siliceous (oxide[b]):			
Gold-silver	24,316	24,316	4.7
Grand total	514,600	514,600	100.0

Character.	Tonnage.	Recovered contents.					Average.				
		Gold.	Silver.	Copper.	Lead.	Zinc.	Gold.	Silver.	Copper.	Lead.	Zinc.
Sulphide:	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*		*Oz. per ton.*	*Oz. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Zinc-iron-lead	97,704	(c)	(c)	(c)	(c)	(d)	e0.03	e4.88	.....	e9.39	f23.00
Iron pyrites	152,223	23,744.01	1,959,621	1,714,724	3,989,755	.....	.156	12.87	0.56	1.31	.....
Lead sulphide	10,991	1,703.38	99,225	20,195	2,658,549	.....	.155	9.03	.09	12.09	.....
Oxide:											
Lead	32,153	5,548.97	218,784	34,914	6,152,882	.....	.173	6.80	.....	9.57	.....
Copper	64	18.46	89	7,037	.....	.....	.288	1.39	5.58	.....	.....
Iron	61,389	1,410.03	312,207	1,566	1,720,661	.....	.023	5.09	.....	1.40	.....
Zinc	135,760	.....	.....	.....	.....	(d)	.....	.....	.....	.....	f27.45
Siliceous	24,316	9,859.68	127,375	50,782	470,897	.....	.405	5.24	.10	.97	.....
Metallics	.....	1,278.56	350	.....	.....	.....	.....	.....	.....	.....	.....
Total	514,600	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[a] For discussion of geology see Emmons, S. F., Geology and mining industry of Leadville, Colo.: U. S. Geol. Survey Mono. 12, 1886; Emmons, S. F., and Irving, J. D., The Downtown district of Leadville, Colo.: U. S. Geol. Survey Bull. 320, 1907.

[b] All the siliceous ore is also oxide and dry. Metallic gold, in quantity 1,278.56 fine ounces, valued at $26,430, and 350 fine ounces of silver came from less than a ton of ore, from siliceous oxide and sulphide ore bodies.

[c] Estimated recovery, as lead and iron concentrates and zinc residues.

[d] Zinc figured as spelter, or as zinc in zinc oxide.

[e] Average assay crude ore, mostly milled. (Lead wet assay.)

[f] Average assay crude. All to zinc smelters.

Classification of Leadville ores.

Character.	Recovered contents.					
	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry, iron, and siliceous ores [a]	233,976	33,335.70	2,258,795	1,417,416	6,026,641	.....
Copper ores [b]	3,991	2,545.36	139,514	353,572	142,373	.....
Lead ores [c]	43,144	7,252.35	318,009	55,109	8,811,431	.....
Zinc ores [d]	138,672	73.92	21,950	1,556	138,009	64,744,523
Copper-lead ores [e]	25	429.68	1,333	3,120	12,299	.....
Lead-zinc ores [f]	94,792	1,313.33	421,215	75,692	13,964,542	29,098,334
Total	514,600	44,950.34	3,160,816	1,906,465	29,095,295	93,842,857

[a] Includes siliceous oxide, iron, and iron-manganese (silver), largest part of iron pyrite. Smelting ores. Also includes metallics.
[b] Sulphide and oxide. Smelting ores.
[c] Sulphide and oxide lead ores. Smelting ores.
[d] Sulphide and carbonate. To smelters.
[e] Sulphide. Smelting ores.
[f] Sulphide. Greater part to magnetic separating mills.

The course of treatment of Leadville ores, from mine mouth to market, was shown graphically in Mineral Resources for 1911, part 1, 1912, page 547, figure 1. With the exception of the quantity of ore, the flow sheet for 1911 applies for 1913.

MINES REVIEW.

California Gulch, Iron Hill, Breece Hill mines, as opened by the Yak tunnel.—The main source of the ore supply from the Yak tunnel was again the property of the Cord Mining Co. (Minnie Lee claim). Besides the operations of the Yak Co. and its auxiliary companies, there were shipments of ore by lessees from other mines controlled and developed by the Yak Co. Other mines from which ore was shipped in 1913 were the Colonel Sellers Fraction, Comstock (or Hopemore), Dolly B., Diamond, Fortune, Habendum, Resurrection, Rubie, Sierra Nevada, South Cord, Vega, and White Cap. The bulk of the ore was iron sulphide, which was shipped chiefly to lead smelters in Colorado, some going to a sulphuric-acid plant at Argentine, Kans., the residues being returned to Colorado. The zinc sulphides went to the Western Chemical Co., at Denver, to Oklahoma smelters, to Pueblo, and to Argentine, Kans. An appreciable tonnage of low-grade zinc carbonate ore from the Cord Co. property and from the White Cap mine went to Oklahoma. A large tonnage of iron concentrates from the closed magnetic separation plant at the mouth of the Yak tunnel was sent to lead smelters. Lead-zinc ore from the dump of the R. A. M. mine was concentrated at the property, at the Leadville district mill, or sent to the Western Chemical Co.

Iron Hill.—The Iron Silver Mining Co., according to its annual report for 1913, mined 55,326 tons of crude ore which, after sorting, yielded 47,668 net tons. From the sale of this ore the sum of $356,492 was realized. The lessees produced 23,844 tons, yielding a net return of $123,079. From the Moyer mine 28,652 wet tons were sold, containing 68 ounces of gold, 156,364 ounces of silver, 6,254,054 pounds of lead, 12,043,592 pounds of zinc, and 509,160 pounds of iron, from zinc-lead, zinc, lead, iron, sulphide and lead carbonate. From the Tucson mine 19,016 wet tons were sold, containing 70 ounces of gold, 105,739 ounces of silver, 3,924,411 pounds of lead, 6,126,050 pounds

of zinc, 7,230 pounds of copper, and 254,227 pounds of iron, from zinc-lead, iron, copper, siliceous, sulphide and lead and zinc carbonate. Lessees produced 23,844 tons of zinc-lead, zinc, iron, lead, siliceous, sulphide and zinc, iron, lead, oxide. During 1913 the greater bulk of the ore produced (from the Moyer mine) was mined from the East ore shoot, above the second level, northeast of the main shaft. This ore shoot * * * has proved to be one of the largest ore bodies ever developed in your property, having been opened to date for a continuous length of 400 feet, showing an average width of 70 feet and thickness of 25 feet. * * * This ore shoot is peculiar in that it is entirely inclosed in white porphyry and has no apparent connection with any of the other, previously worked-out ore bodies that were located along the porphyry-blue limestone contacts. * * * All the evidence afforded as a result [of development] tends to indicate that the East ore shoot represents a portion of the blue limestone that has been split off from the main ore body, carried up to its present location by the coming in of the white porphyry, and subsequently replaced by the ore minerals.

Lead-zinc ore from the A. Y. and Minnie mine was shipped to Coffeyville, Kans., and to Pueblo, Colo. Lead and iron sulphide ores were shipped from the Louisville mine. Lead oxide and iron sulphide ores were shipped from the Adelaide on North Iron Hill, iron-manganese ore from the Benton, lead oxide and zinc carbonate from the Mikado mine and from the Smuggler mine.

Breece Hill.—Breece Hill and South Evans Gulch embrace the chief mines of the gold belt.

Lessees on the property of the Ibex Mining Co. continued to ship iron pyrite, copper and lead oxide, lead sulphide, zinc sulphide, and zinc carbonate ores, as well as considerable metallic gold. Iron sulphide and copper sulphide were shipped from the Garbutt, Mary Alsberg, Maud Hicks, and St. Crispen mines. Copper sulphide was shipped from the St. Louis tunnel. A large tonnage of hematite fluxing ore and siliceous ore was shipped from the Breece-Iron mine. Siliceous oxide from the Ballard, Big Four, Big Six, Black Prince, Chippewa, Great Hopes, Humboldt, Little Bertha, and Robert Burns; zinc carbonate from the Highland Chief; lead oxide and siliceous oxide from the Fanny Rawlings and Nevada mines, were shipped to smelters.

South Evans Gulch—Little Ellen Hill.—The ores of this vicinity carry appreciable gold and silver content. Lead sulphite, siliceous sulphide and oxide ores, and some lead-zinc sulphide ore were shipped from the New Monarch mine. Lead oxide and sulphide, zinc sulphide, dry oxide and sulphide ores were shipped from the Valley mine, and siliceous sulphide from the Silver Spoon mine. Lead oxide and zinc carbonate ores were shipped from the Little Ellen mine.

Stray Horse Gulch.—Siliceous oxide ore was shipped from the Double Decker and Fairplay mines.

Carbonate Hill.—The bulk of the output of zinc carbonate at Leadville came from mines on Carbonate Hill. Large tonnages were shipped from the Big Chief and from the Maid of Erin and other mines of the Western Mining Co. through the Wolftone shaft, and from the Star Consolidated mines. Iron-manganese ore and lead oxide ores were also shipped from the Star mines. Lead oxides and iron-manganese ores were shipped from the Star of the West mine. Iron-manganese ore was shipped from the Agassiz, Castleview, Evalyn,

Modoc, and Yankee Doodle mines. Lead-zinc sulphide and iron-manganese oxide ores were shipped from the Result and other properties of the Small Hopes-Boreel Co.

Fryer Hill.—Lead oxide, iron-manganese oxide, and zinc carbonate ores were shipped from the Chrysolite, Gambetta, Little Chief, Seneca, and Robert E. Lee mines; iron-manganese ore and siliceous oxide from the Dunkin and Matchless mines; and iron-manganese from the Amie, Del Monte, and Shamrock mines. Lead-zinc sulphide from the Denver City mine was shipped to the Leadville district mill, to Canon City, and to Denver.

Printer Boy Hill.—Siliceous oxide, lead sulphide, lead oxide, and zinc carbonate ores, and some metallic gold were shipped from the Lilian mine.

Rock Hill.—Lead oxide, carrying considerable iron and manganese, and zinc carbonate ores were shipped from the La Plata mines, siliceous oxide from the Crown Point mine, and iron-manganese oxide from the Great O'Sullivan mine on Rock Hill, east of Iron Hill, across California Gulch.

Iowa Gulch.—Lead sulphide ore was shipped from the Ella Beeler mine.

St. Kevin—Independence (or Sugar Loaf) district.—Along the base of the Sawatch Range, including St. Kevin and Sugar Loaf Mountain, is a mineralized region, from which an increased yield was made in 1913. Lead oxide and sulphide ores were shipped from the Dinero mine, silver sulphide ore from the Fanchon, dry sulphide ore carrying gold, silver, and lead from the Jimmy Swisher, siliceous sulphide ore carrying silver from the property of the Sugar Loaf Consolidated Co.

Twin Lakes and Lackawanna Gulch districts.—Oxidized gold-silver ore was shipped from the Belle of Granite mine. A considerable tonnage, of ore from the Mount Champion Co.'s property, in Lackawanna Gulch, was milled in the company's amalgamation-concentration mill, the capacity of which was increased from 45 to 100 tons during the year. Also smelting ore, carrying gold of good commercial tenor, was shipped. A shipment of gold ore was made from the Lackawanna Belle and from the Lackawanna Star mine.

Big English Gulch.—Lead oxide ore was shipped from the Collier-Lewis mine and siliceous ore from the Little Crescent mine.

LA PLATA COUNTY.

Production of gold, silver, copper, and lead in La Plata County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*		
1904	12	3,792	$109,151	31,570	2,374	30	$127,526	$33.63
1905	4	5,662	251,940	93,258	2,923	.....	308,724	54.53
1906	8	7,757	303,930	121,711	445	2,228	385,689	49.72
1907	7	7,789	412,499	217,432	.....	340	556,022	71.39
1908	9	2,408	101,300	71,487	.....	.....	139,188	57.80
1909	10	4,135	127,119	74,152	484	2,980	165,869	40.11
1910	8	6,350	390,844	141,537	142	273	467,304	73.59
1911	19	10,058	286,937	69,438	73,728	1,511	333,023	33.11
1912	23	2,761	135,391	47,948	918	6,756	165,334	59.88
1913	24	7,403	312,891	121,122	113,897	4,455	403,899	54.56
Increase (+) or decrease (−)	+1	+4,642	+177,500	+73,174	+112,979	−2,301	+238,565	−5.32

La Plata County in 1913 produced 7,403 tons of ore, yielding $312,891 in gold; silver, valued at $73,158; copper, $17,654; and lead, $196—a total of $403,899, as compared with $165,334 in 1912. With the exception of the output of some bullion from high-grade specimens, all the ore in 1913 was shipped to smelters. The average assay per ton in 1913 was $42.27 in gold and 16.36 ounces of silver.

California[1] *(La Plata) district.*—The mines of this district are located in the La Plata Mountains, in the drainage basin of La Plata River, the nearest town being La Plata, 10 miles from Hesperus, the shipping point on the Rio Grande Southern Railroad. The ores are in general of two kinds, telluride ores and gold, either free or associated with pyrite.

The May Day and Idaho were the principal producing gold-silver mines in 1913. A considerable tonnage of copper ore was shipped from the Copper Hill mine. Some of the other producing mines were the Butterfly, Columbus, Bay City, Jennie Lind, Jumbo, Little Nona, Old Comfort, Ten Broeck, and Unexpected.

On the west slope of the west ridge of La Plata Mountains, in the same district, but in Montezuma County, are some mines and prospects from which no production was made in 1913.

Cave Basin district.—During 1913 there was considerable prospecting and development work done in the New Cave Basin district, and several tons of copper-silver ore, carrying also a little lead and gold, were shipped to the Durango smelter, from the Holbrook and Mary Murphy claims. The district is located in the San Juan National Forest, and advices from the United States Forest Service indicate that the mineralized area lies about 20 miles north and east of Bayfield, in La Plata County, near the La Plata-Hinsdale County line, between Vallecito and Pine Rivers, approximately in secs. 1, 2, 11, and 12, T. 37 N., R. 6 W., with a center on Mount Rundlett, and extending northward into T. 38 N. The altitude is from 9,500 to 11,000 feet. The southwest corner of the San Cristobal quadrangle of the United States Geological Survey includes a portion of the district.

MESA AND MONTROSE COUNTIES.

A car of copper ore was shipped from the Cliff Dwellers mine and a car from the Sunrise mine, in the La Sal district, Montrose County. Some placer gold was recovered by sluicing on the bench gravels of the Dolores River, near Uranium, Montrose County. As far as could be learned, little or no work was done on the copper prospects in Unaweep[2] and Sinbad Valley districts.

---

[1] For discussion of geology see Cross, Whitman, and others, U. S. Geol. Survey Geol. Atlas, La Plata folio (No. 60), 1899; Emmons, W. H., The Neglected mine and nearby properties, Colorado: U. S. Geol. Survey Bull. 260, pp. 121–127. 1905.

[2] For discussion of geology see Butler, B. S., Notes on the Unaweep copper district, Colorado: U. S. Geol. Survey Bull. 580, pp. 19–23, 1914.

MINERAL COUNTY.

Production of gold, silver, copper, lead, and zinc in Mineral County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons		*Fine ozs.*	*Lbs.*	*Pounds.*	*Pounds.*		
1904	10	124,278	$225,487	1,666,309	.....	9,304,854	2,480,178	$1,710,545	$13.75
1905	10	91,338	182,162	814,189	.....	10,576,146	2,513,457	1,319,305	14.44
1906	13	126,164	159,445	1,150,318	.....	13,038,333	3,562,737	1,890,670	14.99
1907	10	104,977	117,946	870,456	.....	10,656,962	1,838,136	1,365,716	13.01
1908	7	61,131	119,063	725,602	.....	1,731,987	1,100,107	628,080	10.27
1909	7	64,941	108,825	891,185	17,401	9,036,816	1,817,296	1,061,220	16.34
1910	9	62,956	121,181	773,722	29,031	8,246,000	2,421,926	1,036,286	16.46
1911	9	65,932	179,196	545,319	33,384	7,674,556	1,258,561	889,481	13.49
1912	10	66,488	86,002	714,909	23,885	5,730,222	308,681	808,771	12.16
1913	12	56,763	50,282	805,343	31,647	3,398,364	454,875	716,615	12.62
Increase (+) or decrease (−).	+2	−9,725	−35,720	+90,434	+7,762	−2,331,858	+146,194	−92,156	+0.46

Creede district.—[1] All the producing mines of Mineral County are included in the Creede district, except a mine situated 10 miles northwest of Creede, which produced in 1912 for the first time, and increased its production in 1913.

The output of Mineral County for 1913 was valued at $716,615, of which $50,282 was for gold, $486,427 for silver, $4,905 for copper, $149,528 for lead, and $25,473 for zinc. The gold and lead yields decreased materially, but silver, copper, and zinc production increased appreciably.

Of the 56,763 tons sold or treated in 1913, there were 27,169 tons sent to mills for concentration only and 29,594 tons were shipped crude to smelters. The average value per ton of all the ore mined, in terms of gross values of recovered metals, was $12.62 in 1913, as against $12.16 in 1912. The ore sent to smelters averaged: Gold, 0.027 fine ounce and silver 24.45 fine ounces per ton; lead, 1.89 per cent. The assay content of zinc concentrates as shipped was 36.07 per cent.

The producing mines were the Alpha, Amethyst, Bachelor, Commodore, Corsair, Creede Mines Co. property, the Last Chance-New York-Volunteer group, Mollie S., Monon, and Solomon-Holy Moses. Part of the ore from the Amethyst, Creede Mines Co. mines, and the Solomon-Holy Moses was milled, the product being lead and lead-zinc concentrates. The remainder of the ore was shipped crude to smelters.

The Equity Mining and Investment Co. shipped in 1913 an increased tonnage of silver-gold ore from its Equity mine, 10 miles northwest of Creede, on the Continental Divide.

[1] For discussion of the geology of the district see Emmons, W. H., and Larsen, E. S., A preliminary report on the geology and ore deposits of Creede, Colo.: U. S. Geol. Survey Bull. 530, pp. 42–65, 1913.

MOFFAT COUNTY.

Fourmile district (near Baggs, Wyo.).—Sluicing of the bench and river gravels along Fourmile Creek recovered $3,560 in gold and 8 ounces of silver. Producing mines were the Golden, Hall, Homestake, Nelson, Overlooked, and Timberlake.

MONTEZUMA COUNTY.

See California district, La Plata County.

MONTROSE COUNTY.

See Mesa and Montrose counties.

OURAY COUNTY.[1]

Production of gold, silver, copper, lead, and zinc in Ouray County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	12	91,244	$2,174,361	264,385	431,048	1,771,523	5,016	$2,457,358	$26.92
1905	14	98,966	2,333,282	306,406	52,333	2,491,808	48,267	2,646,478	27.74
1906	23	48,468	992.179	916,256	297,741	5,025,385	10,377	1,950,615	40.25
1907	25	96,662	2,415,049	352,519	410,720	3,496,958	30,407	2,916,989	30.18
1908	21	96,493	2,028,698	415,070	1,019,574	1,675,411	.....	2,453,636	25.43
1909	30	103,864	3,044,825	345,815	984,269	2,813,932	19,148	3,474,637	33.45
1910	24	111,245	2,195,847	414,250	620,236	4,004,728	.....	2,674,520	24.04
1911	31	133,252	1,952,958	512,800	564,273	3,949,822	.....	2,473,018	18.56
1912	35	89,975	1,049,590	545,177	400,552	2,989,044	140,667	1,595,178	17.73
1913	31	97,336	959.377	537,634	500,329	2,180,591	200,429	1,468,829	15.09
Increase (+) or decrease (−).	−4	+7,361	−90,213	−7,543	+99,777	−808,453	+ 59,762	−126,249	−2.64

The total value of the output from Ouray County in 1913 was $1,468,829, of which $959,377 was for gold, $324,731 for silver, $77,551 for copper, $95,946 for lead, and $11,224 for zinc. This county ranked fourth in the yield of gold and fifth in total value of output. The output of copper and zinc increased slightly, but the yield of gold and lead decreased appreciably and silver decreased slightly.

The operation of the Brown Mountain copper matting plant, at Ouray, for a time increased the yield of copper from this county, and a slightly increased tonnage of zinc concentrates was shipped from the electrostatic plant at Ouray.

The tonnage of ore sold or treated increased from 89,975 tons to 97,336 tons. The average value per ton in gold was $9.86, as against $11.67 in 1912, against $14.66 in 1911, against $19.74 in 1910, against $29.32 in 1909, and $21.02 in 1908.

In 1913, of the 97,336 tons mined, 54,932 tons were treated at amalgamation and cyanidation mills having concentration equipment and an average of $8.29 in gold and 0.15 ounce of silver per ton were recovered as bullion. From this ore sent to amalgamation and cyanidation mills, and from 37,303 tons sent to mills for concentration

[1] For discussion of geology see Cross, Whitman, and Howe, Ernest, U. S. Geol. Survey, Geol. Atlas, Ouray folio (No. 153), 1907, and U. S. Geol. Survey Geol. Atlas, Silverton folio (No. 120), 1905.

only, were produced 16,462 tons of concentrates, averaging $28.93 in gold and 23.01 ounces of silver per ton, and also copper, lead, and zinc, with a total gross value of $52.42 per ton. Crude ore to smelters averaged $5.64 in gold; 29.53 ounces of silver per ton; 1.09 per cent copper; and 2.29 per cent lead, with a total average gross value of $28.89.

Red Mountain district.—This district in 1913 produced 7,593 tons of ore, yielding $64,480 in gold, 23,938 ounces of silver, 60,716 pounds of copper, 193,813 pounds of lead, and 58,737 pounds of zinc, with a total value of $100,167, as compared with $181,585 in 1912. The tonnage from the Barstow mines to the company's concentration mill was less than in 1912. Ore was shipped from the Atlantic, Genessee, Jumbo, and Saratoga mines.

Sneffels district.—This is the principal district in Ouray County. In 1913, from 4 mines, there were sold or treated 62,142 tons of ore, from which were recovered $673,911 in gold, 398,072 ounces of silver, 315,078 pounds of copper, 1,896,391 pounds of lead, and 73,139 pounds of zinc, with a total value of $1,050,720, as against $1,104,159 in 1912 and against $2,162,198 in 1911. The quantity of ore treated in 1913 increased 7,098 tons, but gold and lead decreased, while silver, copper, and zinc increased.

An increased tonnage from the Atlas mine was treated at the company's concentration mill. In October, 1913, the Atlas mill was changed from gravity concentration to the froth-flotation process. The Camp Bird mine produced approximately the same tonnage, but of slightly lower grade than in 1912. The Camp Bird [1] report for the year ended June 30, 1913, shows that 30,012 dry tons were milled, on which the saving of the gold value in the crude ore was 93.79 per cent. Gold content continued to decline. Receipts, by sale of bullion, were $12.51 per ton of ore milled; by sale of concentrates, $9.84 per ton; and from cyanide slags and matte, $0.06 per ton. The total receipts from operating the mine were $22.49 per ton, the total cost of production, including mining, stamp mill, cyanide mill, shipping and selling, general expenses, and depreciation were $14.61 per ton. During the year operations were reduced to a scale where ore could be furnished to but 25 stamps in the 60-stamp mill. Ore reserves were summed as follows: Positive and partly developed ore, 23,000 dry tons, that should yield a profit of $239,000; probable ore, 8,000 dry tons, that should yield a profit of $87,000. This estimate does not include any ore that may be developed on the sixth level.

A greatly reduced tonnage was milled from the Revenue mine. A small tonnage was shipped from the Wheel of Fortune mine.

Uncompahgre district.—The Uncompahgre district, from 22 mines, in 1913 produced 27,601 tons, yielding $220,986 in gold, 115,624 ounces of silver, 124,535 pounds of copper, 90,387 pounds of lead, and 68,553 pounds of zinc, with a total value of $317,942, as against $309,434 in 1912 and $187,802 in 1911. The greater part of the ore was sent to amalgamation-concentration mills, the rest being sent to mills for concentration only or to smelters.

The Bright Diamond-Iron Clad group, operated by the Wanakah Co., was the principal producing property. Most of the ore of this property was sent to the company's amalgamation-concentration

[1] Eng. and Min. Jour., p. 1222, Dec. 27, 1913.

mill, the greater part of the recovered metals contents being in the concentrate. In addition, pyritic gold-silver-copper ore was shipped to the Brown Mountain matting plant at Ouray, which plant was later taken over by the Wanakah Co. Iron sulphide concentrates and some pyritic ore was shipped to Salida.

Ore from the American Nettie mine and from the O. & N. dump was milled in a 3½-foot Huntington mill, with amalgamation and a Wilfley table, and a small tonnage was shipped to Salida. Silver ore was shipped from the Bachelor mine. Ore from the Mickey Breen mine was concentrated into lead and lead-zinc concentrates. Ore was also shipped from the Black Girl, El Mahdi, Grand View, Great Western, Leadville, Wedge, and other mines.

PARK COUNTY.[1]

Production of gold, silver, copper, lead, and zinc in Park County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	12	4,202	$191,324	57,064	.....	156,270	69,000	$234,281	$55.76
1905	19	6,745	320,867	49,202	12,199	543,303	.....	378,023	55.63
1906	16	10,072	395,050	144,815	14,399	966,193	.....	549,928	53.59
1907	24	12,661	513,216	111,215	.....	1,062,732	333,407	662,614	51.78
1908	20	11,372	430,808	12,047	37,106	495,985	728,000	497,138	42.65
1909	16	15,046	551,921	102,375	61,023	2,237,093	366,574	729,079	46.83
1910	17	12,329	265,547	117,037	88,748	2,041,204	659,796	465,460	36.71
1911	25	5,780	58,832	69,072	24,216	923,089	407,772	163,249	24.02
1912	27	2,686	67,981	31,234	10,321	167,756	132,275	105,569	32.10
1913	25	6,598	50,041	94,293	29,161	506,046	98,623	139,303	18.86
Increase (+) or decrease (−)	−2	+3,912	−17,940	+63,059	+18,840	+338,290	−33,652	+33,734	−13.24

[a] Includes placer production.

The value of the metallic output of Park County in 1913 was $139,303, of which $50,041 was for gold, $56,953 for silver, $4,520 for copper, $22,266 for lead, and $5,523 for zinc. There were 21 producing deep mines and 4 placers, as against 20 deep mines and 7 placers in 1912. The placer yield was $14,758 in gold and 139 ounces of silver in 1913, as against $19,233 in gold and 189 ounces of silver in 1912.

Beaver district.—Placer mines in this district were idle.

Buckskin district.—The Buckskin district in 1913 produced 1,236 tons which yielded $5,772 in gold, 1,514 ounces of silver, 2,525 pounds of copper, 87,787 pounds of lead, and 59,056 pounds of zinc, with a total value of $14,247, as against $7,185 in 1912. An increased tonnage from the Paris mine was milled at the amalgamation mill on the property, and several shipments of crude ore to smelter were also made. Lead-zinc ore from the Evening Star, lead ore from the No-End, and copper ore from the Rollins-Phillips mine was shipped.

Consolidated Montgomery district.—From 266 tons shipped to smelters the yield was $2,430 in gold, 8,689 ounces of silver, 3,566 pounds of copper, 15,933 pounds of lead, and 12,799 pounds of zinc, with a

[1] For discussion of geology see Patton, Horace B., Hoskin, Arthur J., Butler, G. Montague, Geology and ore deposits of the Alma district, Park County, Colo.: Colorado State Geol. Survey, Bull. 3, 1912.

total value of $9,649, as against $5,244 in 1912. Producing mines were the Colorado National, Dolly Varden, Galveston, Lucky Queen, Magnolia, Morning Star, Our Fritz, and Sweet Home mines.

Freshwater district (Guffey).—No output was made from this district.

Hall's district.—No output was made from this district.

Horseshoe district.—A considerably increased tonnage of lead-silver-gold ore was shipped from the Chance-Hill Top mine, but the output of zinc carbonate was confined to one shipment. A decreased yield was made from the Snowstorm placers.

Lake George (or Pulver) district.—Two cars of zinc sulphide ore were shipped from the Great Western mine.

Mosquito district.—The value of the output of this district, for many years the principal district in Park County, was only $26,949, of which $22,386 was for gold, as compared with $49,843, of which $42,401 was for gold in 1912.

A decreased tonnage was shipped from the London [1] mine at the head of Mosquito Creek, on the ridge between Leadville and Alma. Shipments were also made from the Baltic, Golden Wave, Kennebec, and Winnie mines.

Tarryall district.—A small quantity of bullion and a car of ore were the output from the Reliance mine. There was an appreciable yield of placer gold from the Fortune placer in this district.

PITKIN COUNTY.[2]

Production of gold, silver, copper, lead, and zinc in Pitkin County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904.....	36	109,770	$971	2,150,035	2,908	9,071,761	44,375	$1,631,338	$14.89
1905.....	25	107,927	248	2,469,520	41,276	22,386,142	5,268,091	2,861,243	26.51
1906.....	27	203,400	1,172	2,131,374	.....	17,951,674	3,673,755	2,676,537	13.11
1907.....	20	183,836	579	1,719,446	10,735	12,235,230	5,799,746	2,128,212	11.58
1908.....	18	133,408	538	1,041,700	.....	7,568,060	722,362	904,449	6.78
1909.....	12	112,448	745	700,038	26,092	13,143,210	34,741	935,191	8.32
1910.....	12	89,037	646	477,813	24,843	13,408,250	.....	851,783	9.57
1911.....	11	88,823	542	450,772	7,408	11,084,334	.....	739,172	8.32
1912.....	9	91,791	165	528,504	22,952	8,405,333	484,507	740,653	8.07
1913.....	13	114,264	29	562,308	48,852	17,528,386	460,161	1,144,253	10.01
Increase (+) or decrease (−)....	+4	+22,473	−136	+33,804	+25,900	+9,123,053	−24,346	+403,600	+1.94

Pitkin County in 1913 produced 114,264 tons of ore, with a total gross value of $1,144,253, of which $29 was for gold, $339,634 for silver, $7,572 for copper, $771,249 for lead, and $25,769 for zinc. The silver yield increased 33,804 ounces and the lead yield increased 9,123,053 pounds, more than doubling the 1912 yield. A considerable tonnage of zinc carbonate ore was shipped. Both the tonnage to

[1] For discussion of geology see Moore, C. J., The London mine, Mosquito district, Colo.: Am. Inst. Min. Eng., Bull. 75, pp. 415–427, March, 1913.

[2] For discussion of geology see Spurr, J. E., Geology of the Aspen mining district, Colorado, with atlas: U. S. Geol. Survey Mon. 31, 260 pp., 1898. $3.60.

mills and to smelters increased. The average content of the ore sold or treated (deducting the tonnage of zinc ore), was 4.96 ounces of silver and 7.73 per cent of lead.

Pitkin County regained fifth place in yield of silver and second to Lake County in the yield of lead.

Aspen (Roaring Fork) district.—At Aspen are located all the large producing mines in Pitkin County. The Smuggler was the principal producing mine, with an increased tonnage of milling ore and a heavily increased tonnage of smelting ore. Smelting ore was shipped from the Argentum-Juniata, Aspen, Della S., Durent, Millinee, Little Annie, and Spar Consolidated mines.

Ashcroft (or Columbia) district.—A shipment of lead-silver ore was made from the Tam O'Shanter-Montezuma mine.

RIO GRANDE COUNTY.

Summitville district.[1]—Gold-silver-copper ore was shipped from the Golconda mines

ROUTT COUNTY.[2]

Hahns Peak district.—A small quantity of placer gold was produced in 1913.

Several tons of ore, carrying very appreciable quantities of gold and silver, were shipped from the Royal Flush mine. Work on a 400-ton concentration mill was started in June and carried on continuously to December. Total development consists of 8,410 feet, of which 783 feet was driven in 1913. Several tons of lead ore were shipped by the Steamboat Mines Corporation.

Slater district.—Assessment work was done on the mines near Slater.

SAGUACHE COUNTY.

Production of gold, silver, copper, lead, and zinc in Saguache County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	5	499	$8,641	47,233	48,066	18,000	18,000	$43,380	$8.968
1905	4	496	699	4,401	1,135	203,797	.....	13,112	26.44
1906	7	999	7,628	737	.....	49,141	.....	10,923	10.93
1907	4	170	649	6,194	1,260	22,528	.....	6,183	36.37
1908	5	76	610	953	76	27,715	.....	2,289	30.12
1909	8	192	1,196	2,260	3,769	83,463	.....	6,450	33.59
1910	8	296	1,025	4,841	5,362	161,068	.....	11,407	38.54
1911	8	184	512	4,664	4,984	74,556	46,561	9,616	52.26
1912	12	9,459	3,805	19,309	29,479	504,845	534,928	80,172	8.48
1913	10	980	4,243	8,694	13,277	336,886	32,964	28,221	28.80
Increase (+) or decrease (−)	−2	−8,479	+438	−10,615	−16,202	−167,959	−501,964	−51,951	+20.32

Saguache County in 1913 produced 980 tons of ore, with a gross value of $28,221, of which $4,243 was for gold, $5,251 for silver, $2,058 for copper, $14,823 for lead, and $1,846 for zinc.

[1] See Conejos County.

[2] For discussion of geology see George, R. D., and Crawford, R. D., The Hahns Peak region, Routt County, Colo.: Colorado Geol. Survey, First Rept for 1908, pp. 189–229, 1909. Gale, H. S., The Hahns Peak gold field: U. S. Geol. Survey Bull. 285, pp. 28–34, 1906; Gold placer deposits near Lay, Routt County, Colo.: U. S. Geol. Survey Bull. 340, pp. 84–95, 1908.

Baca Grant (Crestone) district.—Small lots of ore were shipped from the Anna L., Honest Abe, and Pelican mines.

Cochetopa district.—A shipment of zinc sulphide ore was made from the Alaska mine.

Kerber Creek (Bonanza) district.—This was the principal producing district in Saguache County in 1913, but with a greatly decreased yield. Lead ore was shipped from the Antoro mine and from the Empress Josephine; copper-lead ore from the Elizabeth and from the Silver Queen mines. Lead-zinc ore from the Bonanza mine was milled at the Kortwright mill, and lead ore was shipped to smelters.

At the Rawley mine no development work was done except diamond drilling, assessment, and sampling. Development work totals 13,650 feet. There is an 100-ton concentration plant on this property.

SAN JUAN COUNTY.[1]

Production of gold, silver, copper, lead, and zinc in San Juan County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	31	233,663	$1,736,229	1,584,938	3,575,219	10,303,414	1,384,340	$3,610,509	$15.45
1905	20	204,139	1,050,971	750,844	1,675,858	8,045,126	248,627	2,158,705	10.57
1906	26	196,438	900,175	690,076	1,549,663	4,515,317	584,476	1,954,637	9.94
1907	27	235,639	967,732	1,175,176	2,450,280	12,483,507	237,677	2,909,053	12.35
1908	42	202,643	997,824	1,004,287	2,282,738	8,402,569	10,131	2,184,801	10.78
1909	40	187,041	683,267	793,637	1,653,192	9,085,068	786,518	1,744,003	9.32
1910	54	206,272	[a] 710,257	[a] 782,250	1,208,496	10,688,386	3,781,259	1,960,898	9.50
1911	38	108,088	[a] 336,463	[a] 325,604	470,912	6,933,822	2,224,351	1,006,707	9.31
1912	41	140,917	523,574	714,974	1,063,291	9,114,334	2,478,594	1,719,894	12.21
1913	38	123,343	657,612	880,409	1,221,516	9,508,979	1,664,999	1,890,349	15.33
Increase (+) or decrease (−)	−3	−17,574	+134,038	+165,435	+158,225	+394,645	−813,595	+170,455	+3.12

[a] Includes placer production.

San Juan County in 1913 produced 123,343 tons of ore, with a gross value of $1,890,349, of which $657,612 was for gold, $531,767 for silver, $189,335 for copper, $418,395 for lead, and $93,240 for zinc.

During 1913 there were treated at amalgamation and cyanidation mills 52,056 tons of ore, with an average recovery per ton in bullion of $3.49 in gold and 0.06 ounce silver; there were also 60,455 tons sent to mills for concentration only, a total of 112,511 tons (91 per cent of all the ore mined), which yielded 19,058 tons of concentrates, averaging $20.92 per ton in gold, 12.42 ounces of silver, and also copper, lead, and zinc, with a total gross value per ton of $53.71.

Crude ore shipped to smelters—10,832 tons—averaged $7.12 in gold, 59.17 ounces of silver, 3.20 per cent copper, and 11.74 per cent lead.

Animas district (including the mines in the immediate vicinity of Silverton, and south and east of the Animas River from Silverton to Middleton).—The Animas district in 1913 produced 36,267 tons of ore, yielding $146,950 in gold, 701,101 ounces of silver, 506,644 pounds

[1] For discussion of geology see Cross, Whitman, Howe, Ernest, and Ransome, F. L., U. S. Geol. Survey Geol. Atlas, Silverton folio (No. 120), 1905.

of copper, 5,774,530 pounds of lead, and 217,574 pounds of zinc, with a total value of $915,208, as compared with $739,965 in 1912.

There were 26 producing mines in 1913, the same as in 1912. The principal producing mines in the district were the Iowa-Gold Tiger group and the Silver Lake mines. The Silver Lake mines were operated on company account for three months only, when the mines were leased. Most of the ore was milled, producing lead and zinc concentrates, but a considerable tonnage was shipped crude to the smelter. The output of the Iowa-Gold Tiger mine was milled, lead concentrates being produced. Lead ore from the Dives and copper-lead from the Highland Mary mine were shipped to smelters. Ore from the Intersection mine was treated by amalgamation and concentration. Other producing mines were the Aspen, Bandora, Big Three, Bonner, Green Mountain, Kansas City, Mayflower, North Star, Pride of the West, and Shenandoah.

Eureka district (north of Silverton, including Chattanooga, Gladstone, Animas Forks, Eureka).—This district in 1913 produced 87,076 short tons of ore, yielding $510,662 in gold, 179,308 ounces of silver, 714,872 pounds of copper, 3,734,449 pounds of lead, and 1,447,425 pounds of zinc, with a total value of $975,141, as against $954,575 in 1912. There were 12 producing mines in 1913, against 15 in 1912. An increased tonnage was milled at the Sunnyside mill, by amalgamation, concentration, and electrostatic separation. Lessees on the Gold King mine operated 40 of the 80 stamps continuously, with an increased yield of concentrates. The tonnage of lead-zinc ore from the Silver Ledge mine, at Chattanooga, treated by concentration, fell off heavily. Some copper ore was shipped from this mine. Copper-lead ore was shipped from the Congress mine. A large tonnage of lead-zinc ore from the Frisco tunnel property was concentrated. Other producing mines were the Hematite, Joe and John, Scotia, and Silver Doctor.

SAN MIGUEL COUNTY.[a]

Production of gold, silver, copper, lead, and zinc in San Miguel County, Colo.,[a] 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.[b]	Silver.[b]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	25	231,316	$1,728,838	1,329,184	245,709	6,184,375	.....	$2,791,077	$11.77
1905	19	291,338	1,711,853	1,275,079	17,721	6,970,152	.....	2,812,362	9.58
1906	21	386,735	2,447,790	1,672,522	70,725	7,158,189	.....	3,990,047	10.31
1907	29	407,491	2,467,516	1,438,299	14,905	5,274,641	.....	3,699,330	9.08
1908	26	428,231	2,317,651	1,543,187	382,402	5,555,049	952,872	3,464,114	8.08
1909	10	423,609	2,285,051	1,344,152	501,285	4,941,370	804,296	3,305,088	7.80
1910	43	481,000	2,494,793	1,144,050	544,189	7,791,841	2,193,981	3,643,008	7.57
1911	28	429,354	2,447,841	1,000,834	971,064	6,456,333	3,386,088	3,583,208	8.35
1912	26	455,692	2,399,234	1,153,709	845,497	7,429,622	2,943,783	3,785,726	8.31
1913	27	509,175	2,129,371	1,051,096	736,374	6,967,136	2,405,750	3,319,647	6.52
Increase (+) or decrease (−).	+1	+53,483	−269,863	−102,613	−109,123	−462,486	−538,033	−466,079	−1.79

[a] For discussion of geology see Purington, C. W., Preliminary report on the mining industries of the Telluride quadrangle, Colo.: U. S. Geol. Survey, Eighteenth Ann. Rept., pt. 3, pp. 745–850, 1898. Cross, Whitman, and Purington, C. W., U. S. Geol. Survey, Geol. Atlas, Telluride folio (No. 57), 1899. Hess, F. L., Notes on the vanadium deposits near Placerville, Colo.: U. S. Geol. Survey Bull. 530, pp. 142–156. 1912.

[b] Includes placer production.

The value of the metallic production of San Miguel County in 1913 was $3,319,647, of which $2,129,371 was for gold, $634,862 for silver, $114,138 for copper, $306,554 for lead, and $134,722 for zinc.

In gold yield, San Miguel maintained its place as second to Teller, and in silver, held second place after Lake. In total gross value of metals produced, San Miguel stood third, with Teller first, Lake second, and San Juan fourth.

During 1913 there were treated at amalgamation and cyanide mills 480,609 short tons of ore, or 94 per cent of all the ore mined; and an average of $2.71 in gold and 0.78 ounce of silver per ton was saved as bullion. The gold saved as bullion in 1913 represented 61 per cent of the gold produced in the county, and the silver in bullion represented 36 per cent of the county silver output.

There were 27,659 tons of ore sent to mills for concentration only, a total of 508,268 tons milled (99.8 per cent of all the ore mined), which yielded 31,330 tons of concentrates, averaging $26.38 in gold, 19.84 ounces of silver, and $17.14 in copper, lead, and zinc, a total of $55.51, as compared with $65.87 in 1912.

Crude ore to smelters—907 tons—averaged $1.84 in gold, 57.8 ounces of silver per ton, and 0.24 per cent copper and 22.26 per cent lead.

Upper San Miguel district.—The Upper San Miguel district in 1913 produced 484,595 tons of ore, yielding $2,039,203 in gold, 993,923 ounces of silver, 731,498 pounds of copper, 6,557,560 pounds of lead, and 2,405,750 pounds of zinc, with a total value of $3,176,129, as compared with $3,497,479 in 1912. Three large companies, the Liberty Bell, the Smuggler Union, and the Tomboy, furnished more than 90 per cent of the total output.

The annual report for the Tomboy Gold Mines Co. (Ltd.) for the year ending June 30, 1913, states:

> The company milled 129,618 dry tons of ore, yielding an average of $8.02 per ton. Receipts, by bullion, produced $2.76 per ton. Concentrates produced, $5.26 per ton, total receipts, $8.09 per ton; expenditures, total working cost, $4.39 per ton, total cost of production, $4.88 per ton. The Montana mine, recently purchased, furnished 41 per cent of the ore milled. The average content of the ore from this mine was as follows: Gold, 0.48 ounce; silver, 4.51 ounces; lead, 1.03 per cent; zinc, 2.18 per cent; iron, 4.13 per cent; copper, 0.28 per cent.
>
> The increase in tonnage for the year was brought about by the use of coarser screens in the batteries, and the regrinding of that portion of the pulp that is sent to the middlings mill, by two Hardinge conical mills. This has decreased the recovery of free gold by amalgamation, and to remedy this this company is contemplating installing two additional Hardinge mills below the batteries. Recent experiments have been made with flotation and electrostatic processes. These tests were still in progress and indicated that a better recovery could be made on the zinc-middlings product. The ore reserves are estimated at 426,000 tons, 264,000 tons in the Argentine group and 162,000 tons in the Montana group.[1]

The Liberty Bell mine and 80 stamp, 500-ton, amalgamation, concentration, and cyanidation mill were actively operated. In May, 1913, this company completed the installation of additional equipment for cyanidation of concentrates by fine grinding and agitation by Dorr continuous decantation wash. For five months of the year concentrates were sold to smelters, and for seven months treated at the mill. The ore is partly oxidized and partly sulphide, with siliceous and calcareous gangue, oxidation extending to 2,300 to 2,400 feet and continuing in lower levels.

[1] See Eng. and Min. Jour., Jan. 3, 1914, p. 31; Min. Mag. (London), November, 1913, p. 2[illegible], adv. section.

The Smuggler Union mines and 140 stamps, 500-ton amalgamation, concentration, and cyanidation mill were steadily operated.

Ore from the Ballard mine was treated by amalgamation and concentration in the 10-stamp, 25-ton mill completed December, 1913. Ore from the Cimarron mine was treated by amalgamation and concentration. Ore from the Nellie mine was treated by amalgamation in the small mill on the property. The Alta mine and concentration mill were operated continuously. A 200-ton cyanidation plant [1] was completed at the property of the Junta Consolidated Gold Mining Co.

Iron Springs (Ames and Ophir) district.—The Iron Springs district in 1913 produced 23,972 tons of ore, yielding $83,985 in gold, 56,083 ounces of silver, 4,608 pounds of copper, and 375,507 pounds of lead, with a total value of $135,095.

There were 12 producing mines in the district. Crude ore to smelters was shipped from the Baltimore, Bottoms, Carbonero, Oro Cashier, and Parsons mines. The Butterfly-Terrible mine and mill were operated the greater part of the year. A small tonnage from the Carribeau mine was concentrated. Ore from the Little Mary mine was treated by amalgamation. A small tonnage from the Lake Superior-Ophir mine was treated by amalgamation and concentration. A considerable tonnage from the Suffolk and other mines of the Ophir Gold Mines Co. was treated by cyanidation.[2] Lead ore and lead concentrates were shipped to smelter from the San Bernardo mine and mill.

Lower San Miguel (Sawpit and Placerville) district.—Bullion was marketed from the treatment of ore from the Golden Rose mine.

Mount Wilson district.—Lead ore was shipped from the Morning Star mine and a small quantity of bullion was recovered from specimens from the Orion mine.

SUMMIT COUNTY.

Production of gold, silver, copper, lead, and zinc in Summit County, Colo., 1904–1913.

Year.	Number of producing mines.	Tonnage.	Gold.		Silver.[a]	Copper.	Lead.	Zinc.	Total value.	Average value per ton.
			Placers.	Deep.						
		Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*		
1904	37	35,475	$94,240	$108,203	292,149	.....	5,592,140	2,512,778	$739,995	$18.20
1905	34	36,930	33,728	123,748	209,356	.....	2,181,660	3,320,237	582,359	14.85
1906	39	34,050	53,199	86,574	107,752	27,120	1,301,912	2,942,983	470,932	12.25
1907	39	25,127	37,214	69,376	125,847	21,865	1,915,133	3,026,627	474,095	17.37
1908	28	14,631	145,370	41,571	66,025	28,523	1,719,190	1,232,149	355,816	14.42
1909	32	31,098	405,360	47,406	99,763	3,839	3,559,278	5,798,167	971,292	18.11
1910	29	47,040	347,204	21,562	152,250	21,740	5,015,409	5,542,685	973,725	13.27
1911	41	55,904	257,422	26,819	182,957	22,888	6,024,867	7,675,175	1,092,673	11.91
1912	39	46,606	392,739	33,276	164,665	16,412	4,402,422	9,342,725	1,372,749	20.96
1913	45	40,360	386,196	76,032	167,490	18,170	3,944,268	6,931,074	1,127,896	18.31
Increase (+) or decrease (−)..	+6	−6,246	−6,543	+42,756	+2,825	+1,758	−458,154	−2,411,651	−244,853	−2.65

[a] Includes placer production.

Summit County deep mines in 1913 produced 40,360 tons of ore, yielding $76,032 in gold; silver valued at $98,519; copper, at $2,816;

[1] For description of plant see Eng. and Min. Jour., Feb. 7, 1914, p. 343.

[2] For description of process see Parmelee, H. C., Cyaniding slimy ore by continuous decantation: Metal. and Chem. Eng., January, 1913, pp. 25–28; see also Min. Mag. (London), February, 1913, p. 144.

lead, at $173,548; and zinc, at $388,140—a total of $739,055, as compared with $977,051 in 1912. Dredges and other placer operations yielded $386,196 in gold and 4,379 ounces of silver, valued at $2,645, a total of $388,841, against $392,739 in gold and 4,812 ounces of silver, a total value of $395,698 in 1912.

Summit County is the principal placer producing county in Colorado, and in production of zinc ranks second to Lake County.

Breckenridge district.[1]—Breckenridge district includes Bevan, Minnesota, and Union districts; includes the mines near Breckenridge, on French Gulch, and on Blue and Swan rivers; and includes all the placers in the county. The value of the total output of gold, silver, copper, lead, and zinc from both deep and placer mines was $1,018,465, or 90 per cent of the county yield, and a decrease for 1913 of $232,079, as compared with the yield in 1912, but an increase of $153,334 as compared with the yield in 1911.

The principal producing property is the Wellington mines. The production in 1913 was not equal to that of 1912 because in June the 100-ton wet-concentration mill was closed, although the roasting and magnetic separation mill[2] was operated all year on zinc middlings from former years' operations.

A small tonnage of lead ore from the Monte Cristo mine was treated in the company's 60-ton concentration plant. Lead-zinc ore was shipped from the Bullion King mine. An increased tonnage from the Laurium (or Blue Flag) mine was concentrated at the company's mill. Zinc sulphide of good grade was shipped from the Country Boy mine. A considerable quantity of metallic gold was recovered from pockets in the Dunkin mine, from which also an appreciable tonnage of lead ore was shipped. A considerable tonnage of lead ore was shipped from the Lucky and Standard mines. Other producing mines were the Brooks Snyder, Congress, Dreadnaught, Germania, Iowa, Montana, and Washington.

Only 3 of the 4 dredges in the district were operated in 1913. The Reliance dredge, in French Gulch, is of the double-lift, open-connected type, with buckets of a capacity of 9 cubic feet. The French Gulch Dredging Co., or Reiling dredge, is of the Bucyrus type. Only 1 of the 2 dredges of the Colorado Gold Dredging Co. was operated in 1913, and one of the dredges was partly dismantled. Both dredges are of the Bucyrus open-connected type, with buckets of a capacity of 9½ cubic feet.

The Washington placer was operated by hydraulicking, the Snyder placer by drifting and hydraulicking, and the Mekka by hydraulicking.

Consolidated Tenmile[3] *district (Frisco, Kokomo, and Robinson).*—This district in 1913, from 14 mines, produced 3,409 short tons of ore, yielding $13,671 in gold, 25,926 ounces of silver, 3,667 pounds of copper, 664,221 pounds of lead, and 265,632 pounds of zinc, with a total value of $73,999, as compared with $109,414 in 1912. The Robinson mine and roasting, magnetic separator, and wet-concentration mill[4] were idle.

[1] For discussion of the geology of the district see Ransome, F. L., Geology and ore deposits of the Breckenridge district, Colorado: U. S. Geol. Survey Prof. Paper 75, 1911.

[2] For description of magnetic plant see Parmelee, H. C., Zinc ore dressing in Colorado: Metal. and Chem. Eng., September, 1912, pp. 525–528.

[3] For discussion of geology see Emmons, S. F., U. S. Geol. Survey Geol. Atlas, Tenmile district special folio (No. 48), 1898.

[4] For description of mill see Parmelee, H. C., Zinc ore dressing in Colorado: Metal. and Chem. Eng., February, 1911, pp. 91–96.

Lead oxidized ore to lead smelters and lead-zinc sulphide ore to the Western Chemical Co. were shipped from the Boston mine, and lead-zinc ore to the Western Chemical Co. was shipped from the Nettie B. mine. Shipments were made from the Arcadia, Excelsior, Felecia Grace, Free America, Lead King, Michigan, Queen of the West, Raven, Reconstruction, Summit, and Wintergreen mines.

Montezuma district.[1]—There was considerable activity in this district during 1913. Lead ore to smelters and lead-zinc ore to the Sutton Steele & Steele dry-concentration plant at Denver were shipped from the Bessie Cora mine. A shipment of lead-zinc ore was made from the Bolivar mine and lead ore was shipped from the Montezuma mine. A large tonnage of the old dump of the St. John mines was excavated by steam shovel and trammed to the 500-ton jig and table concentration mill. The New Pennsylvania mines and concentration mill were operated part of the year.

TELLER COUNTY.

Production of the Cripple Creek District, Colorado, 1891–1913.[a]

Year.	Number of producing mines.	Tonnage.[b]	Gold, value.	Silver.		Total. value.
				Quantity.	Value.	
		Short tons.		*Fine ozs.*		
1891			$449			$449
1892			583,010			583,010
1893			2,010,367	5,019	$3,915	2,014,282
1894			2,908,702	25,900	16,317	2,925,019
1895			6,879,137	70,448	45,791	6,924,928
1896			7,512,911	60,864	41,387	7,554,298
1897			10,139,709	57,297	34,278	10,174,087
1898			13,507,244	68,195	40,235	13,547,479
1899			15,658,254	82,520	49,512	15,707,766
1900			18,073,539	80,166	49,703	18,123,242
1901			17,261,579	90,884	54,530	17,316,109
1902			16,912,783	62,690	33,226	16,946,009
1903			12,967,338	42,210	22,793	12,990,131
1904	102	597,819	14,456,536	47,817	27,734	14,484,270
1905	88	716,358	15,641,754	56,951	34,740	15,676,494
1906	105	702,069	13,930,526	67,943	46,201	13,976,727
1907	83	451,082	10,370,284	51,630	34,076	10,404,360
1908	96	601,173	13,031,917	52,270	27,703	13,059,620
1909	83	575,670	11,466,227	63,204	32,866	11,499,093
1910	83	688,941	11,002,253	54,263	29,302	11,031,555
1911	92	756,900	10,562,653	57,783	30,625	10,593,278
1912	74	849,172	11,008,362	66,117	40,662	11,049,024
1913	77	917,406	10,905,003	71,349	43,095	10,948,098
Total			246,790,537	1,235,520	738,791	247,529,328
Increase (+) or decrease (−) for 1913 over 1912	+3	+68,234	−103,359	+5,232	+2,433	−100,926

[a] Figures for 1891–1903 from reports of the Director of the Mint: figures 1904–1913 actual recovery by mills and smelting. In 1907 the Portland Co. installed a cyanide plant to treat the accumulated tailings of previous years and to treat tailings from the chlorination barrels. The United States Reduction & Refining Co. has also a cyanide plant auxiliary to the Standard chlorination plant, and old tailings of previous years as well as tailings from day to day from the Standard plant are treated here.

[b] Mine reports.

CRIPPLE CREEK DISTRICT.[2]

In 1913 there were recovered from ore from the Cripple Creek district by mills and smelters, from crude ore and dump ore, from the treatment of tailings of previous years, from tailings of operations in

[1] For discussion of geology see Patton, H. B., The Montezuma mining district of Summit County, Colo.: Colorado Geol. Survey First Rept., 1908, pp. 104–144, 1909.

[2] For discussion of geology, see Lindgren, Waldemar, and Ransome, F. L., Geology and ore deposits of the Cripple Creek district, Colorado: U. S. Geol. Survey Prof. Paper 54, 1906.

1912, from slags, slimes, and "clean-ups" of mills, and from stolen bullion and ore, 527,529.51 fine ounces of gold, valued at $10,905,003, as compared with $11,008,362 in 1912.

THE CRIPPLE CREEK DRAINAGE OR ROOSEVELT TUNNEL.

The Roosevelt tunnel continued slowly to lower the water in the mines. At the beginning of the year 1914 the El Paso shaft had been sunk to the tunnel level; the recession of water at the Elkton mine had been 84 feet; the water at the Portland property, 7,000 feet from the Roosevelt tunnel heading, had dropped 102 feet. The Vindicator and the Golden Cycle mines were not benefitted by the drainage and the two companies by joint agreement raised the water from both properties by electric pumps at the Golden Cycle. An extension of the tunnel is in prospect.

MILLS AT COLORADO CITY.

Over 95 per cent of the crude ore from Cripple Creek is treated at mills in the district or at custom mills near Colorado City, the remainder of the crude ore and some concentrates and "clean-up" material going to smelters.

The valley mills adjoining Colorado City are the Golden Cycle, a roast-cyanide (with subsidiary amalgamation) plant, of 1,200 tons daily capacity; the Portland, a 400-ton roast-cyanide-concentration mill; and the Standard, a chlorination-concentration plant with cyanide annex. The Standard plant was idle in 1913, with the exception that a "clean-up" of the plant was made.

At Florence, Fremont County, the tailings of the old Union chlorination mill were treated in a 500-ton cyanide plant built in 1911 by the United States Reduction & Refining Co. This plant was operated only part of the year.

MILLS IN THE CRIPPLE CREEK DISTRICT.

The Stratton's Independence mill, at Victor, started in April, 1909, with a capacity of 4,500 tons per month, was enlarged to treat 7,000 tons in December of that year, and in November, 1910, with the addition of the second unit, attained a capacity of 9,000 tons. During 1911 the capacity was brought up to approximately 10,000 tons a month, and 109,800 tons were treated in the year ending June 30, 1911, and 112,391 tons in the year ending June 30, 1912. According to the annual report [1] for the year ending June 30, 1913, dump ore milled was 104,111 tons; mine ore, 25,999 tons; total, 130,110 tons; total ounces of gold contained in ore 20,013, ounces of gold per ton 0.1538, total ounces of gold recovered 15,707, per cent recovered in concentrates 34.43, in bullion 44.05; total milling cost per ton $1.318, and mining dump ore $0.122; total cost at mill $1.44 per ton.

The Portland Gold Mining Co.'s new concentration cyanide plant was completed at Victor in June, 1910. The annual report of the Portland Co. for 1913 says, regarding the Victor mill:

> The mine also produced 127,054 tons of low-grade ore, a large part of which was the reject from the ore shipped to the Colorado Springs plant. In addition to this, 51,108 tons of low-grade ore were taken from the dumps, making a total of 178,162 tons treated at the Victor mill, of an average assay of $2.95+ per ton, or total of $526,186.80 [from

[1] Eng. and Min. Jour., Feb. 7, 1914, p. 329.

which] $402,923.44 [the gross values recovered by new mill] [was recovered]. During the year an addition was built to the main building, in which were installed one additional Chilean mill, one ore bin, and eight concentrating tables, with their necessary equipment.

Other operating mills in the district (all cyanide) were the Ajax, a 200-ton concentration cyanide plant; the Dante (Gaylord) leaching mill; the Isabella 50-ton leaching plant, with merely coarse crushing of ore; the Jo Dandy (Kavanaugh) leaching mill; the Rex leaching mill; and the Wild Horse coarse-crushing mill.

MINES REVIEW.

Poverty Gulch.—The El Paso Gold King mine continued to be a producer.

Hoosier Pass.—The Hoosier mine was operated by the Grafton Gold Mining Co. A small production was made from the Pride of Cripple Creek mine.

North Slope of Ironclad Hill.—Producing mines were the Jerry Johnson, W. P. H., and Damon.

Gold Hill.—Producing mines were the Anchoria-Leland, Bonanza King, Caledonia, Clara D., E. Porter Gold King, International, and Midget.

Raven and Guyot Hills.—Producing mines were the Doctor-Jack Pot, Elkton, Hobo, Maggie, Mary McKinney, Moose, Mountain Monarch, Peggy, Jennie Sample, Jo Dandy, and Ophir.

The twenty-first annual report of the Elkton Co. for the calendar year 1913, dated February 9, 1914, shows—

that the total net tonnage of marketable ore from all sources was 32,007 tons of a gross value of $597,890, averaging $18.68 per ton, and of a gross cash return value to the company of $408,636, averaging $12.77 per ton. * * * During the year 1913 the recession of the water level has been 84 feet and the main shaft has been sunk 84 feet, at which depth a station has been cut. * * * This thirteenth level is practically at the water level of the district, and the recession of water is about 7 feet per month.

The report of the Mary McKinney Mining Co. shows there were produced on company account 13,924 tons of ore with a gross value of $293,434 and by lessees 2,740 tons with a gross value of $52,662. The shaft was sunk to the tenth level, a depth of 1,030 feet.

The report of the Jennie Sample Consolidated Mining Co. shows that lessees mined 1,440 tons of ore of a gross value of $27,571.

Beacon Hill.—Producing mines were the Banner, C. K. and N., El Paso, Mary Nevin, Prince Albert, Gold Dollar, Henry Adney, and Mabel M.

The report of the El Paso Consolidated Gold Mining Co., dated March 3, 1913, shows that—

in the year 1913 the company shipped 28,524 tons of ore, of an average gross value of $15.26 per ton, and lessees shipped 9,121 tons of an average gross value of $18.05 per ton, a total of 37,645 tons, with a gross value of $600,012. * * * In the El Paso mine * * * a low-grade ore-bearing zone was found to occur at an elevation of approximately 8,600 feet above the sea level and has extended practically throughout the mine from the 600 to the 800 foot levels. * * * Development * * * has shown that ore of excellent grade has been opened below this low-grade zone and both width and value are distinctly encouraging for the future. * * * The main shaft has been completed from the 1,000-foot level to the 1,332-foot or Roosevelt tunnel level.

Bull Hill.—Producing mines were the Block 8, School Section 16, Blue Bird, Dante, Dexter, Gold Sovereign, Last Dollar, Modoc, Ramona, Rubie, Stratton estate mines, Trilby, and Wild Horse.

The gross production of the Union Leasing Co. on the Gold Sovereign during 11 months of 1913—no shipments made in December—was slightly more than 4,665 tons, with a total value of $56,647. The shaft was deepened 98 feet.[1]

The United Gold Mines Co. controls several suosidiary mining companies and leases its mines at Cripple Creek. The report covers the year ended December 31, 1913. No ore was produced on company account, and the output by lessees, amounting to 20,259 tons, valued at $11.36 per ton, was made up as follows:

Output of United Gold Mines Co., 1913.

		Tonnage.	Average value.
W. P. H.	Ironclad Hill	5,622	$24.47
Damon	do	314	10.02
Montrose Co.	do	329	12.90
May B.	Squaw Mountain	214	18.38
Deadwood	Bull Hill	1,007	9.14
Wild Horse	do	1,509	24.63
Requa Co.	do	350	6.40
B. H. and S. M. Co.	do	7	5.35
Total		9,352	

The Wild Horse mill was operated under lease and treated 11,593 tons, yielding $39,206.[2]

Mines between Altman and Goldfield.—The producing mines were the Burns, Christmas, Findley, Golden Cycle, Isabella, Mountain Beauty, Pharmacist, Shurtloff, Victor, and Vindicator.

The annual report[3] for the Acacia Gold Mining Co. shows that, with the exception of the South Burns shaft, the property was worked by lessees. Total (net) receipts were $10,303, including $2,032 for royalties.

The report of the Isabella Mines Co. shows that the

ore shipments and sales for the year 1913 were: Mine ore, 11,385 tons; dump ore, 6,903 tons; total, 18,288 tons; total gross value, $243,252; average value per ton of mined and dump ore, $13.30.

The Vindicator Gold Mining Co., in its annual report, shows

that the profit from operations has been the largest in the history of the company. During the year ending December 31, 1913, at the No. 1 shaft, 73,084 tons of crude ore were produced on company account, yielding 22,829 net tons, or 31.24 per cent of shipping ore, of a gross gold content of $702,119, or $30.75 per ton. Lessees working through No. 1 shaft produced 2,222 net tons of a gross content of $85,965 or $38.69 per ton. * * * Lessees working through other shafts on the property produced 8,466 net tons, of a gross gold content of $132,273, or $15.62 per ton. * * * Development work of a total length of 10,187 feet was done. * * * Development of the 1,600-foot level progressed in a most satisfactory manner. * * * Other ore bodies were opened on 1,200, 1,300, 1,400, and 1,500 foot levels. * * * The water from our property has been allowed to drain into the Golden Cycle, to be pumped to the surface under our joint agreement with them.

Battle Mountain.—Producing mines were the Ajax, Carbonate Queen, Coriolanus, Dead Pine, Eclipse, Granite, Gold Coin, Mary Cashen, Necessity, Portland, Stratton's Independence, and Strong.

[1] Min. and Eng. World, Feb. 7, 1914, p. 293.
[2] Min. and Sci. Press, Mar. 14, 1914, p. 47.
[3] Min. and Sci. Press, Mar. 7, 1914, p. 430.

As shown by the twentieth annual report (dated February 2, 1914), of the Portland Gold Mining Co.,

during the year there were 53,245 tons of ore mined and shipped to the Colorado Springs mill, having an assay value of $25.93 per ton. The mine also produced 127,054 tons of low-grade ore, a large part of which was taken out in the course of development work, and the remainder was the reject from the ore shipped to the Colorado Springs plant. In addition to this, 51,108 tons of low-grade ore were taken from the dumps, making a total of 178,162 tons treated at the Victor mill, of an average assay value of $2.95 per ton. * * * No great amount of development work or crosscutting has been done on the lower levels of the mines for several years, especially below the eleventh level at No. 1 shaft, but for the coming year a plan has been adopted * * * for an extensive system of development work and prospecting all over the company's property * * *. The development work on the seventeenth level alone, as now planned, involves over 2 miles of crosscutting and drifting.

The work of sinking shafts No. 1 and No. 2 is being prosecuted vigorously, and it is expected that each of these shafts will reach a point 150 feet below the present sixteenth level by the 1st of April, after which this new level, to be known as the seventeenth level, will be opened up as rapidly as possible. * * *

The Portland property is situated about 7,000 feet from the Roosevelt tunnel heading, which does not permit of the drainage of your property as rapidly as we would like. The average drainage for the year in the Portland mine was about 8½ feet per month. This tunnel should drain your property to a further depth of about 500 feet.

Gross value of ore mined and shipped	$1,380,713
Gross values recovered by new mill	402,923
	1,783,636
Net cost for mining and milling	1,185,153
Gross profit on operation	598,483

The grand total of production from April 1, 1894, to December 31, 1913, was 1,767,592 net tons, of a gross value of $36,268,797.

The report [1] for the Stratton's Independence mine for the fiscal year ending June 30, 1913, shows that—

no ore bodies of importance were discovered, hence the area of stoping ground was diminished. The net production from lessees has rapidly declined during the past two years, decreasing $60,791 for the year ended June 30, 1912, and $127,264 during the year under review. The production of shipping ore by the company shows a decrease of $20,072 over the previous fiscal year.

[1] Eng. and Min. Jour., Feb. 7, 1914, p. 329. See also Metall. and Chem. Eng. January, 1914, p. 11, and Min. and Sci. Press, Dec. 27, 1913, p. 1030.

ANTIMONY.

By Frank L. Hess.

PRODUCTION.

No antimony ores were mined during the year so far as was reported to the United States Geological Survey. Prices were too low. As has been pointed out in the Survey's reports, at the usual prices antimony ores can not be worked profitably under the high labor costs prevailing in the mining regions of the United States unless the deposits are very large and advantageously situated. No deposits of antimony ores have been found in the United States which fulfill these conditions, and as a result practically all the antimony metal used here is imported from European and Japanese smelters, mostly from England. The ores for these smelters come largely from China, Mexico, France, and Austria.

For several years the production of antimony in the United States from domestic ores has been confined to that contained in antimonial lead and small quantities recovered in the electrolytic refining of copper and lead. A production of antimony from foreign ores, which can only be estimated, is also made. The antimonial lead is mostly a by-product in the smelting of the precious metals, and efforts are made to save all possible, so that this production can not be largely increased. The quantity saved in electrolytic copper refining can probably be increased, though not enough to make it a serious factor in the market.

The following table shows the production of antimony in the United States since 1909:

Production of antimony in the United States, 1909–1913, in short tons.

Year.	Contained in antimonial lead of domestic origin.		Contained in antimonial lead of foreign origin, but smelted in the United States.		Antimony produced from domestic ore.		Recovered from old alloys, scrap, dross, etc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1909	1,617	[a] $252,252	743	[a] $115,908	[b]	[b]	1,556	[a] $242,736
1910	1,598	[c] 263,431	631	[c] 103,906			[d] 2,779	[c] 457,979
1911	1,543	[e] 264,780	711	[e] 122,006			[d] 2,369	[e] 406,520
1912	1,224	[f] 209,059	725	[f] 123,830			[d] 2,506	[f] 428,025
1913	2,204	[g] 375,562	304	[g] 53,801			[d] 2,705	[g] 460,932

[a] Estimated, using 7.8 cents as the average price per pound.
[b] None produced from domestic ore. Figures not collected for foreign ores.
[c] Estimated, using 8.24 cents as the average price per pound.
[d] Figures collected by J. P. Dunlop, United States Geological Survey. In 1910 a total of 9 tons, in 1911, 10 tons, in 1912, 13 tons, and in 1913, 45 tons was recovered as antimony, the remainder as alloy.
[e] Estimated, using 8.58 cents as the average price per pound.
[f] Estimated, using 8.54 cents as the average price per pound.
[g] Estimated, using 8.52 cents as the average price per pound.

The total of 2,508 tons of antimony produced from both domestic and foreign ores in 1913 was contained in 16,665 tons of antimonial lead, of which it formed 15.05 per cent. The percentage of antimony in the antimonial lead is lower than that reported for 1912, in which year the percentage was 22.8.

The values given in the table are arbitrary and must not be taken as exact. Antimonial lead generally contains impurities, such as arsenic, iron, and copper, and it is impracticable to obtain pure antimony and pure lead from the alloy at a cost low enough to afford a profit, though the alloy sells at a lower price than the metals singly. A rule by which antimonial lead is sometimes sold is to add the price of the contained antimony, supposing it to be equal to Cookson's, to that of the contained lead and then to subtract $5 per ton. For lack of a better basis, for the year 1913 the value of the antimony content has been figured at 8.52 cents per pound, the average price of Cookson's during the year.

Although the production of antimony in antimonial lead is indirect, it is quite as important as the production of an quivalent quantity of segregated antimony, for there is a demand for antimonial lead which would have to be met by alloying the two metals were they not thus produced, and in fact most of the antimony imported both as metal and as ore is thus used.

IMPORTS.

For years large quantities of antimonial lead were imported into the United States under the name type metal, for which it is largely used; but during the last two years these imports have decreased greatly. The following table showing imports of type metal for consumption is taken from the records of the Bureau of Foreign and Domestic Commerce:

Type metal imported and entered for consumption, 1904–1913, in short tons.

Year.	Type metal.		Antimony content.	
	Quantity.	Value.	Quantity.	Percentage.
1904	4,072	$221,127	630	15.5
1905	6,966	456,155	1,228	17.6
1906	9,801	900,608	1,853	18.9
1907	7,416	932,027	1,369	18.4
1908	2,055	156,847	422	20.5
1909	6,997	532,108	1,327	19.0
1910	6,697	485,493	1,109	15.1
1911	4,195	310,658	727	17.3
1912	291	18,668	52	18.0
1913	284	20,098	50	17.3

In the customs returns the lead content only is given, and it is assumed that the remainder is practically all antimony. This assumption is, however, wholly arbitrary, for imported type metal contains as much as 2 per cent of impurities, such as iron, arsenic, and copper, but there is no way of estimating its impurities. The antimony content is therefore probably too large by some quantity less than or approximately equal to 2 per cent of the total quantity of type metal, and the correct percentage is correspondingly lower.

Old type weighing 86 short tons, valued at $10,398, and new type weighing 23 short tons, valued at $8,876, were also imported in 1913.

In the following table the imports of antimony and antimony ore for consumption, as obtained from the Division of Statistics, Bureau of Foreign and Domestic Commerce, are given since 1904 in order to show the great variation in both quantity and value of the imports from year to year. The imports of salts of antimony are given from 1904 to 1910, the earliest and latest years for which the Survey has obtained statistics.

Antimony, antimony ore, and salts of antimony imported and entered for consumption in the United States, 1904–1913, in pounds.

Year.	Metal and regulus.		Crude antimony and ore.		Oxide and salts of antimony.		Total value
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1904	4,268,045	$248,726	2,488,518	$50,414	981,026	$70,668	$369,808
1905	4,941,247	431,228	1,970,788	53,026	1,010,228	80,130	564,384
1906	10,305,734	1,391,289	1,972,658	125,841	764,070	99,251	1,616,279
1907	9,600,901	1,407,861	2,771,387	180,903	682,192	98,038	1,686,802
1908	8,089,915	771,206	3,287,218	106,930	623,125	65,898	944,034
1909	9,557,956	620,117	3,453,542	94,249	955,360	60,353	774,719
1910	7,955,945	492,570	1,346,962	47,185	326,136	14,201	553,956
1911	8,486,137	470,552	1,641,467	60,459	[a] 1,003,647	54,426	585,437
1912	13,936,873	808,473	1,562,066	51,444	[a] 1,759,908	81,077	940,994
1913	12,479,727	798,581	4,021,486	137,780	[b] 1,968,475	117,169	1,053,530

[a] Oxide only. No figures showing the imports of antimony salts are now given in the customs returns.
[b] Imports of salts are included for the last three months of 1913.

PRICES.

The price of antimony has not fluctuated greatly during the last six years, the extreme monthly averages as given by the American Metal Market and Daily Iron and Steel Report [1] being 7.22 and 10.31 cents a pound for Cookson's antimony, and both prices prevailed in 1913, the lower being that for February and the higher that for November. Hallett's generally sells for about a cent a pound less than Cookson's, and other brands are lower according to quality and to reputation, which seems to be fully as important. The average price of Cookson's for 1913 was 8.52 cents a pound.

CONSUMPTION.

The approximate domestic consumption of antimony is equal to the production, recovery, and imports. For 1913 the consumption was roughly as follows:

Domestic consumption of antimony in 1913, in short tons.

	Quantity.	Value.
Antimony contained in antimonial lead from all sources, including by-product antimony	2,540	$430,491
Recovered from wastes, scrap, etc. (including a little ore), nearly all as alloy	2,775	462,115
Imports:		
Metal and regulus	6,240	798,581
Crude antimony and ore (probable antimony content)	1,200	137,780
Approximate consumption of metallic antimony	12,755	1,828,967

[1] Metal Statistics, 1913, p. 243.

ARSENIC.

By Frank L. Hess.

PRODUCTION AND IMPORTS.

The output of arsenic in the United States during 1913 was all in the form of white arsenic or arsenious oxide commonly known as "arsenic," and amounted to about 2,513 short tons, valued at $159,236, against 3,141 tons, valued at $190,757, in 1912, a decrease of 628 tons in quantity and of $31,521 in value.

White arsenic was produced in this country only from smelter flue or bag-house dusts and by the same three firms which produced it in 1912. The Anaconda Copper Co. saved white arsenic from fumes made in smelting Butte copper ores at the Great Washoe Smelter at Anaconda, Mont. At Midvale, Utah, the United States Smelting Co. sublimed white arsenic from bag-house dusts collected in smelting Tintic and other Utah ores. The American Smelting & Refining Co. saved its output from flue dusts made from both domestic and foreign ores.

There is so little direct profit in the manufacture of white arsenic, owing mostly to the long distances it must be shipped to market, that the smelting companies make it largely because they must prevent its escape into the atmosphere. If the demand and prices justified a larger output the production could be greatly increased.

The domestic production and the imports of arsenic compounds of which a record has been kept at the customhouses since 1902 are given in the following table:

Production and imports of arsenic, 1902–1913.

Year.	Production of white arsenic.		Imports.[a]			
			"Arsenic or arsenious acid" and "Arsenic, and arsenic sulphide or orpiment."		Paris green and London purple.	
	Quantity (short tons.)	Value.	Quantity (short tons).	Value.	Quantity (pounds).	Value.
1902	1,353	$81,180	4,055	$280,055	.....	.....
1903	611	36,691	4,179	294,602	.....	.....
1904	36	2,185	3,400	243,380	28,498	$985
1905	754	35,210	3,838	256,540	44,931	1,118
1906	737	63,460	3,987	350,045	311,293	21,347
1907	1,751	163,000	5,164	574,998	133,422	21,919
1908	(b)	.....	4,964	430,400	195,000	30,764
1909	1,214	52,946	4,036	303,728	183,765	20,370
1910	1,497	52,305	5,139	314,306	181,363	14,648
1911	3,132	73,408	4,096	247,323	126,191	4,972
1912	3,141	190,757	6,156	428,741	162,272	6,950
1913	2,513	159,236	4,701	410,446	99,692	4,431

[a] Figures furnished by the Division of Statistics, Bureau of Foreign and Domestic Commerce.
[b] There were only two producers of arsenic in the United States in 1908, so that the figures of production may not be given.

CONSUMPTION.

The consumption of arsenic is practically equivalent to the domestic production plus the imports, but besides these a small quantity of arsenic is produced in arsenical or hard lead in smelting arsenical gold and silver ores, and is used for making shot. The use of this hard lead corresponds to the use of antimonial lead similarly produced in smelting. The consumption amounted to about 7,200 short tons of white arsenic, arsenic acid, arsenic sulphide (orpiment and realgar), and elemental arsenic, and 50 tons of Paris green and London purple of foreign production. With the copper arsenate, sodium arsenate, arsenic chloride, arsenical sheep dip, lead arsenate, and other unrecorded imports of arsenic compounds, it is probable that the total consumption was equal to more than 7,500 tons of arsenic compounds, a decrease of 2,500 tons from the consumption of 1912.

ERRATUM.

Page 285, second paragraph. The statement that the bismuth in the ores was not paid for does not apply to the Highland Mary mine.

BISMUTH.

By Frank L. Hess.

Writing upon bismuth production and markets in the United States has always been unsatisfactory on account of the secrecy of buyers and smelters and the consequent difficulty of obtaining exact information. As with tin, platinum, cobalt, and nickel, no large deposits of even fairly high-grade bismuth ores have been found in the United States, but, on the other hand, there have been discovered from time to time many small bismuth deposits, or deposits of other ores, particularly of lead, of which small portions were rich in bismuth-bearing minerals. Although many lots of these ores have been mined which carried from 6 to 18 per cent of bismuth, besides gold, silver, and lead, the ores have generally been sold with no payment to the miner for the bismuth content.

Two such instances were quoted in the bismuth report [1] of the United States Geological Survey for 1910. One lot of ore produced from the Highland Mary mine, at Leadville, Colo., contained from 11.6 to 15.97 per cent of bismuth, and ore from the Comstock mine, near La Plata, Colo., carried 18 per cent of bismuth; but buyers gave nothing for the bismuth in either ore; yet at 50 cents a pound for the contained bismuth the ore from the Comstock mine should have been worth $180 a ton—much more than the value of the gold and silver which it contained. From the Indiana mine, at Ouray, Colo., 50 tons of ore, containing 20 to 26 per cent of bismuth, are reported to have been sold to a smelter which allowed nothing for the bismuth.

Occasionally such lots have been sold for bismuth, but the market has been inconstant and miners have become discouraged in trying to obtain what seemed to them a fair price.

It has been stated many times by brokers and others in conversation with the writer, and also by the technical press, that bismuth prices are positively fixed by a group of European producers, composed of one English firm and several Saxon firms, and that territory in which each may operate is also fixed. To the English firm is allotted the United States as a part of its field. The Geological Survey has no direct knowledge of these conditions, but the steady and uniformly high price of metallic bismuth lends color to the statements. It is also stated that should producers of bismuth ores sell to any possible competitor of the foreign syndicate, the syndicate would thereafter refuse to buy ores from the miner at any price. Competition has been closed by taking advantage of the fact that the American production has been sporadic and therefore uncertain. It is also

[1] Hess, F. L., Bismuth: U. S. Geol. Survey Mineral Resources, 1910, pt. 1, p. 729, 1911.

stated that through its agents the syndicate has refused to sell bismuth to users if at any time they patronized a competitor. Record was kept of consumers' purchases, so that their needs were known, and it could be told whether they were obtaining supplies elsewhere. As the other sources were not entirely dependable, the refusal of the syndicate to sell might mean to a manufacturer of bismuth salts that at some time he could not get the metal he needed and that his trade would be taken by others. Buyers have thus been made afraid and would not purchase bismuth supplies of American production unless tempted by prices so low as to allow the purchaser to hold his cheap stock for gradual consumption.

In addition to the uncertain deposits of bismuth and the rich bismuth-bearing ores of other metals, however, the United States has much greater bismuth resources in minute quantities of bismuth which accompany many ores of gold, silver, copper, and lead. Nearly all of these ores, that are mined, are finally assembled at the smelters, where the bismuth has generally gone out of the stacks as fume or into pig, base, or antimonial lead, and so has been lost. The amount of bismuth thus lost has probably exceeded the world's consumption. The work of E. M. Dunn [1] indicated that when tested in 1911, the dusts, amounting to 76.8 tons a day, which were caught in the flues at the great Washoe smelter at Anaconda working on Butte copper ores, carried 1.15 per cent of bismuth trioxide (Bi_2O_3) equivalent to 1.03 per cent of bismuth, indicating about 1,580 pounds a day or 288 tons a year. However, although, according to Dunn's figures, the dusts carry 20 pounds of bismuth per ton, worth during 1913 at least $35 (the New York market price was $1.75 to $2.25 a pound), he concludes that it is not worth saving. It seems safe to prophesy that, if prices remain as they are now, a process will in time be evolved for isolating bismuth from flue dust as rich as this. Probably the larger part but not all of the bismuth in copper ores goes out through the smelter stacks. A table given by Eilers [2] shows the following recoveries of bismuth from blister copper when refined electrolytically:

Recovery of bismuth per ton of blister copper.

Location of smelter.	Bismuth.	Location of smelter.	Bismuth.
	Pounds.		*Pounds.*
Garfield, Utah [a]	6.1	Tacoma, Wash. [e]	5.7
Steptoe, Nev. [b]	0.33	Aguascalientes, Mexico [f]	4.0
Omaha, Nebr. [c]	18.6	Cerro de Pasco, Peru [g]	13.5
Mountain, Cal. [d]	27.3	Mount Lyell, Tasmania [h]	4.3

[a] The blister copper comes principally from the Bingham "porphyry" mines.
[b] From the "porphyry deposits" of the Nevada Consolidated Copper Co., at Ely.
[c] Principally from concentrated copper-lead mattes shipped from lead-silver plants of the Rocky Mountain region to the converters at the Omaha lead refinery.
[d] From ores of the Mountain Copper Co. at Iron Mountain, Shasta County, Cal.
[e] From Pacific coast and Alaska copper ores.
[f] From gold and silver ores low in copper, from all parts of Mexico.
[g] From copper and lead mattes from local depsosits.
[h] From low-grade local copper deposits.

[1] Dunn, E. M., Determination of gases in smelter flues; and notes on the determination of dust losses at the Washoe reduction works, Anaconda, Mont.: Am. Inst. Min. Eng. Bull. 80, pp. 2088–2089, August, 1913.
[2] Eilers, Anton. Notes on some of the rarer metals in blister copper: Am. Inst. Min. Eng. Bull. 78, pp. 999–1000, June, 1913.

Most, if not all, of the blister coppers listed are those refined by the American Smelting & Refining Co., and though similar information has not been given by the other large refining companies, there is no reason to suppose that other blister coppers will not carry similar quantities of bismuth; but no bismuth is known to be commercially saved from the slimes made in electrically refining copper, though experimentally a little has been obtained in this way. It will be noted in the table given that the blister copper from the Mountain, Cal., smelter carried more than 1 per cent bismuth. Base lead likewise carries bismuth in considerable quantity, and in 1906 the United States Metals Refining Co. erected an electrolytic refining plant at Grasselli, Ind., where they have since been saving bismuth in considerable quantity.

During 1913 the American Smelting & Refining Co. began refining a part of its base lead electrolytically at its plant at Omaha, Nebr., and saved bismuth from the anode slimes.

Bismuth must be removed from the best grades of corroding lead used in making white lead for paint, and during 1913 the National Lead Co. saved a quantity of bismuth from this source.

With the adoption of the Cottrell process of fume precipitation, another large potential source of bismuth is being provided; and should it prove feasible to separate the bismuth from the mass of dust and fume, it seems probable that enough bismuth will be produced to supply the present American market entirely and possibly to provide for larger markets developed by cheaper bismuth. The quantity of bismuth now produced in this country is comparatively large and has apparently made a considerable difference in the imports, but without making a market for the miner or reducing the price to the consumer.

Whether the producer of bismuth ores will have a better market for his product is questionable. The companies saving bismuth as a by-product may hereafter be able to furnish all the market will take without the use of bismuth ores.

The production of bismuth during the year is thought to have been at least 157,300 pounds, valued at $273,650. The output of one producer is estimated and is probably low.

During 1913, according to figures obtained from the Division of Statistics, Bureau of Foreign and Domestic Commerce, 117,747 pounds of metallic bismuth, valued at $213,257, were imported for consumption. This is a decided drop from the imports of 1912 and preceding years, which probably is to be explained by the large increase in the domestic output.

Imports for consumption of metallic bismuth into the United States, 1904–1913, inclusive.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1904	185,905	$339,058	1909	183,413	$286,516
1905	148,589	318,007	1910	198,174	332,668
1906	254,733	318,452	1911	172,093	311,771
1907	259,881	325,015	1912	182,840	316,440
1908	164,793	257,397	1913	117,747	213,257

The apparent consumption of bismuth was approximately equivalent to the imports plus the domestic production, and is estimated to have been about 275,000 pounds. This estimate is probably under, rather than over, the actual quantity. The prices quoted during 1913 ranged from $1.75 to $2.25 a pound, but during the latter half of the year it was uniformly $1.95 to $2.15 a pound, as given by The American Metal Market.

The principal bismuth-producing foreign countries, with the quantity and value of ore or bismuth produced by each in 1912, are given in the table below. Sufficient data are not available to reduce the quantities to a common basis, such as the metal or an ore containing a certain percentage of metal. The figures for the production in 1913 are not yet at hand.

Foreign production of bismuth in 1912, by countries.

Country.	Material.	Quantity.	Value.
		Pounds.	
Australia:			
New South Wales [a]	Native metal and ore	12,992	$5,888
Queensland [b]	do	227,808	53,765
Tasmania [c]	do	17,002	12,877
Bolivia [d]	Ore	1,055,799	83,637
Peru [e]	Metal in ore	112,518	68,885
Saxony [f]	Refined metal	7,145	12,763
Spain [g]	Ore	160,965	1,801

[a] New South Wales Dept. Mines, Ann. Rep., 1912, p. 59, 1913. As given, the figures are 5.8 long tons of metal and ore, valued at £1,210.

[b] Queensland Government Min. Jour., Brisbane, vol. 14, p. 125, Mar. 1913. The figures as given are: Bismuth, 5 long tons, 19 cwt.; bismuth and wolfram, 191 long tons, 10 cwt. For convenience, the bismuth-wolframite mixture is treated as being half bismuth ore, as no figures are given to show the exact contents. One-half the value also is taken.

[c] Wallace, W. H., The progress of the mineral industry of Tasmania: Quarters ending June 30, 1912 (p. 1), and Dec. 31, 1912 (p. 1), Hobart, 1912 and 1913.

[d] Figures given by the Pan American Union.

[e] Jimenez, Carlos P., Estadística minera del Perú en 1912: Cuerpo Ing. Minas Perú Bol. 80, p. 11, 1914. As given, the figures are 289.1 toneladas of ore containing 51,038 kilograms of bismuth. Value, libras 14,155.

[f] Jahrbuch Berg- und Hüttenwesen im Königr Sachsen, 1913 (Statistik vom Jahre 1912), Freiburg, p. B 252, 1913.

[g] Min. Jour., London, May 23, 1914, p. 497.

SELENIUM AND TELLURIUM.

By Frank L. Hess.

During 1913 selenium was produced from the anode muds in electrolytic copper refining by the American Smelting & Refining Co., Nichols Copper Co., and Raritan Copper Works. The production amounted to 29,097 pounds, valued at about $46,900.

Prices in large lots ranged from $1.60 to $1.75 a pound.

The production of selenium is governed wholly by the demand. It can be considerably increased from the anode slimes made in electrolytic smelting. Another prolific source is to be found in the uranium and vanadium ores now mined in southwestern Colorado and southeastern Utah. These ores are in sandstones containing uranium and vanadium minerals. Practically all of the vanadium-bearing ores except pure carnotite carry selenium. Dr. W. F. Hillebrand thinks that the selenium occurs native. In many specimens collected in Utah and Colorado selenium was almost invariably present. The percentage is not large, but if the demand should justify, the ores could be easily roasted, thus driving off the selenium, which, with little trouble, could be condensed and saved. This occurrence will be treated at greater length in an article on the Utah uranium and vanadium deposits which is now in preparation.

The Raritan Copper Works produced a small quantity of tellurium, which was likewise obtained from copper anode muds. The tellurium was shipped to Europe.

IRON ORE, PIG IRON, AND STEEL.

By Ernest F. Burchard.

INTRODUCTION.

The course of the iron industry in 1913 was unusual in several respects. The production of iron ore, pig iron, and steel exceeded that of any previous year, and stocks of finished products were reasonably low at the close of the year, yet this apparently favorable record does not accurately reflect the actual conditions for the year as a whole. As recorded in this chapter a year ago, the year 1912 was characterized by recovery from the industrial stagnation of 1911. The buoyant activity of the closing months of 1912 characterized the first quarter of 1913. During this quarter the demand for iron and steel products was strong and greatly stimulated preparations for a record-breaking output of iron ore during the mining season. Production of iron and steel continued at a high rate during the second and third quarters of the year, even though buying had been checked, but prices were greatly lowered, and finally, in the closing months of the year, production of these metals greatly declined, prices dropped nearly to the low level of 1911, and stocks of iron ore at the mines showed an increase of more than 21 per cent over those at the close of 1912, compared with a decrease of more than 16 per cent in 1912. These conditions are graphically shown in the curves of monthly production and prices of pig iron, figures 5 and 6, pages 323 and 326 of this chapter.

It has been decided to continue the feature of the iron ore report introduced in the chapter for 1912—that of including detailed tables both of the quantity of iron ore mined in the various States and districts and of the quantity of iron ore marketed. Reported stocks of ore at each individual mine have been checked and in many instances revised figures have been obtained from the producers which balance closely with ore mined and marketed, although it can not be expected that there will ever be exact accord from year to year between these three sets of figures, since the tonnage of ore in stock piles is necessarily partly estimated, and there are generally variations in the mine reports from year to year. The beneficiation of iron ore, which is now receiving attention from a steadily increasing number of ore producers, tends to further complicate the statistics of ore mined and ore marketed; for if all the ore that is subjected to treatment be included under "quantity mined," irrespective of whether it originally is in a marketable state or not, and if the resulting washed or dried ore, nodulized or sintered ore, and magnetic concentrates, be taken as the quantity marketed, then the loss in weight of tailings must be accounted for. Heretofore, and also in the present report, the ore as mined has been considered as market-

able, the beneficiation process having been regarded simply as a process for enhancing the value of the ore. The quantity mined thus represents the tonnage of crude ore mined, and the quantity marketed represents the shipments of crude ore from the mines, whether direct to the consumer or to the beneficiating plant. The stocks at mines

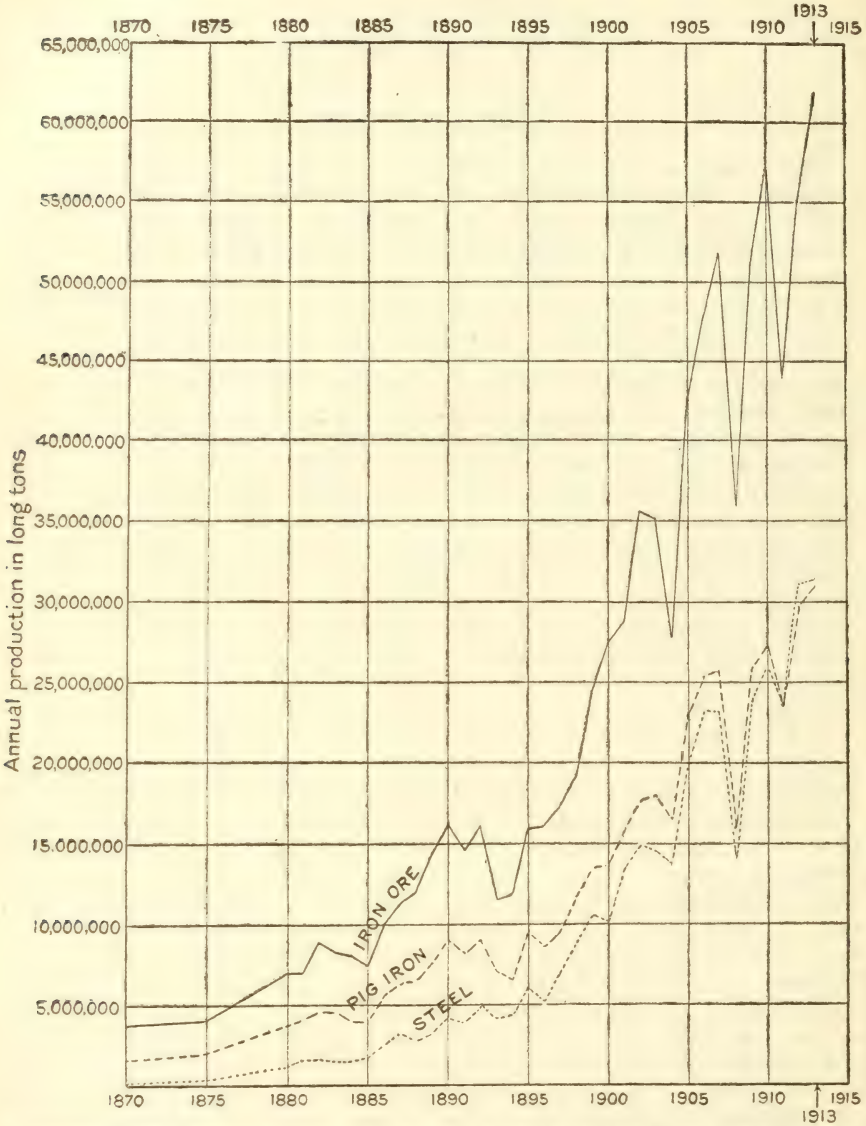

FIGURE 4.—Curve showing production of iron ore, pig iron, and steel in the United States, 1870–1913.

likewise represent crude ore. It is hoped that it may be possible to present some statistics of beneficiated ore in future reports.

In response to many recent requests for a printed list of Survey publications on iron ore, a bibliography of Survey publications and also of the more important reports issued by State geological surveys is given at the end of this chapter.

IRON ORE INDUSTRY IN THE UNITED STATES.

IRON ORE MINED AND MARKETED IN 1913.

The quantity of crude iron ore mined in the United States in 1913 amounted to 61,980,437 long tons, as compared with 55,150,147 long tons mined in 1912, an increase of 6,830,290 long tons, or 12.38 per cent. The quantity of iron ore shipped from the mines (marketed) in the United States in 1913 amounted to 59,643,098 long tons, valued at $130,905,558, as compared with 57,017,614 long tons, valued at $107,050,153, marketed in 1912. This represents an increase in quantity of 2,625,484 long tons, or 4.60 per cent, and in value of $23,855,405, or 22.28 per cent. The average price of ore per ton for the whole country in 1913 was $2.19, as compared with $1.88 in 1912. These quantities of ore, both mined and marketed, include the iron ore used for fluxing other metallic ores at smelters in the Middle and Western States, but do not include the iron ore sold for the manufacture of paint. The quantity of iron ore for paint marketed in 1913, which is reported in detail in another chapter of Mineral Resources, amounted to 16,950 long tons, valued at $44,851. The ore reported as sold for fluxing purposes other than in the manufacture of pig iron amounted to 62,842 long tons, valued at $235,588, in 1913, as compared with 88,449 long tons, valued at $244,315, in 1912. The domestic iron ore actually marketed for the manufacture of pig iron amounted in 1913 to 59,580,256 long tons, valued at $130,669,970, as compared with 56,929,165 long tons, valued at $106,805,838, in 1912.

A graphic comparison of the annual production of iron ore and its derived metals since 1870 is afforded by the curves shown in figure 4. It must be borne in mind, however, that the figures for the three products are not strictly comparable, because considerable foreign iron ore enters into the production of pig iron, and because a considerable tonnage of scrap iron and steel is used in the production of new steel.

PRODUCTION OF IRON ORE BY GEOGRAPHIC DIVISIONS.

The States in which iron ore occurs may be conveniently grouped into six geographic divisions, namely:

1. *Northeastern States.*—Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, and Ohio.
2. *Southeastern States.*—Maryland, the Virginias, Kentucky, Tennessee, North Carolina, Georgia, and Alabama.
3. *Lake Superior States.*—Michigan, Wisconsin, and Minnesota.
4. *Mississippi Valley States.*—Iowa, Mississippi, Missouri, Arkansas, and Texas.
5. *Rocky Mountain States.*—Idaho, Montana, Wyoming, Colorado, New Mexico, Utah, and Nevada.
6. *Pacific slope States.*—Washington and California.

Each of these divisions may be subdivided into mining districts and the ores classified with regard to variety and to distribution of deposits. These subdivisions are discussed in another section. The Lake Superior is by far the most important of these divisions, and is followed in order by the southeastern division and the northeastern division; the Mississippi Valley and the western divisions are of

minor importance. The table following shows the relative output of iron ore in each of these geographic divisions during 1911, 1912, and 1913.

Iron ore mined in the United States, by geographic divisions, in 1911, 1912, and 1913, in long tons.

Division.	1911		1912		1913	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total.
Northeastern	2,098,923	4.79	2,139,058	3.88	2,316,041	3.74
Southeastern	5,291,879	12.06	5,665,386	10.27	6,307,064	10.18
Lake Superior[a]	35,672,804	81.30	46,483,798	84.29	52,518,158	84.73
Mississippi Valley	65,975	.15	46,480	.08	66,586	.11
Rocky Mountain	[b] 746,971	1.70	812,917	1.48	770,496	1.24
Pacific slope	([b])	.....	2,508	.....	2,092	.....
Total	43,876,552	100.00	55,150,147	100.00	61,980,437	100.00

[a] Includes all Wisconsin mines. [b] Pacific slope included in Rocky Mountain division.

QUANTITY OF IRON ORE MINED AND MARKETED BY STATES.

Iron ore was mined in 28 States in 1913, as compared with 27 States in 1912. Of these States, three—Idaho, Montana, and Nevada—produced ores for fluxing only; part of Colorado's production was for fluxing and part for pig iron; the magnetic ore of Utah was shipped to a Salt Lake iron foundry for testing a new method of reduction and the remainder was used for fluxing; the remaining States produced iron ore for blast-furnace use only, except small tonnages for paint from Georgia, Michigan, New York, and Wisconsin, which are reported in the chapter on Mineral Paints.

The rank of the five States producing the largest quantity of iron ore—Minnesota, Michigan, Alabama, New York, and Wisconsin—remained unchanged in 1913, but there were a few changes in the relative rank of certain of the smaller producers.

The Minnesota iron ranges are producing at present considerably more iron ore than is produced in all the rest of the States together, having furnished 62.37 per cent, or more than five-eighths, of the total for the United States in 1913. The Lake Superior district, comprising all the mines in Minnesota and Michigan and those in northern Wisconsin, mined 52,377,362 long tons in 1913, or 84.51 per per cent of the total production.

Of the two following tables, the first gives a comparison of the iron ore mined and marketed by States for 1912 and 1913, showing the rank of each State and the percentage of the total mined and marketed in the several States; and the second shows the quantity and value of the iron ore marketed in 1912 and 1913, by States, together with the increase or decrease in tonnage and the percentage of increase or decrease in the various States.

Rank of States in mined and in marketed production of iron ore, 1912 and 1913.

1912.

State.	Mined.		
	Rank.	Quantity, in long tons.	Percentage of total.
Minnesota	1	34,431,768	62.43
Michigan	2	11,191,430	20.29
Alabama	3	4,563,603	8.28
New York	4	1,216,672	2.21
Wisconsin	5	860,600	1.56
Pennsylvania	6	517,081	.94
Virginia	7	446,305	.81
Tennessee	8	416,885	.76
New Jersey	9	364,673	.66
Georgia	10	134,637	.24
Missouri	11	43,480	.08
Ohio	12	10,346	.02
Utah	13	7,280	.01
Other States[a]	.....	945,387	1.71
Total	.....	55,150,147	100.00

State.	Marketed.					
	Quantity.			Value.		
	Rank.	Long tons.	Percentage of total.	Rank.	Amount.	Percentage of total.
Minnesota	1	34,249,813	60.07	1	$61,805,017	57.74
Michigan	2	12,797,468	22.44	2	29,003,163	27.09
Alabama	3	4,776,545	8.38	3	5,734,371	5.36
New York	4	1,167,405	2.05	4	2,933,024	2.74
Wisconsin	5	1,152,250	2.02	5	2,731,574	2.55
Pennsylvania	6	522,172	.92	9	481,353	.45
Tennessee	7	416,885	.73	8	564,443	.53
Virginia	8	412,520	.72	7	903,130	.84
New Jersey	9	366,823	.64	6	1,192,816	1.11
Georgia	10	135,337	.24	10	227,282	.21
Missouri	11	42,120	.07	11	92,996	.09
Ohio	12	20,861	.04	12	40,986	.04
Utah	13	7,280	.01	13	22,586	.02
Other States[a]	.....	950,135	1.67	.....	1,317,412	1.23
Total	.....	57,017,614	100.00	.....	107,050,153	100.00

[a] California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Montana, Nevada, New Mexico, North Carolina, Texas, West Virginia, and Wyoming.

Rank of States in mined and in marketed production of iron ore, 1912 and 1913.

1913.

State.	Rank.	Mined.	
		Quantity, in long tons.	Percentage of total.
Minnesota	1	38,658,793	62.37
Michigan	2	12,841,093	20.72
Alabama	3	5,215,740	8.42
New York	4	1,459,628	2.36
Wisconsin	5	1,018,272	1.64
Wyoming	6	537,111	.87
Pennsylvania	7	489,056	.79
Virginia	8	483,843	.78
Tennessee	9	370,002	.60
New Jersey	10	325,305	.53
New Mexico	11	164,085	.26
Georgia	12	155,236	.25
North Carolina	13	69,235	.11
Missouri	14	39,354	.06
Utah	15	14,690	.02
Ohio	16	7,849	.01
West Virginia	17	7,808	.01
Kentucky	18	3,400	
Montana	19	2,475	.01
California	20	2,092	
Other States [a]	.....	115,370	.19
Total	.....	61,980,437	100.00

State.	Rank.	Marketed.				
		Quantity.		Rank.	Value.	
		Long tons.	Percentage of total.		Amount.	Percentage of total.
Minnesota	1	36,603,331	61.37	1	80,789,025	61.72
Michigan	2	12,668,560	21.24	2	33,479,954	25.58
Alabama	3	5,333,218	8.94	3	6,648,569	5.08
New York	4	1,420,889	2.38	4	3,100,235	2.37
Wisconsin	5	896,243	1.50	5	2,149,397	1.64
Virginia	6	492,649	.83	6	983,279	.75
Pennsylvania	7	478,693	.80	8	589,038	.45
Tennessee	8	364,092	.61	9	493,556	.38
New Jersey	9	291,653	.49	7	980,303	.75
New Mexico	10	164,085	.28	11	148,405	.11
Georgia	11	153,336	.26	10	237,876	.18
Missouri	12	37,134	.06	12	83,628	.06
Utah	13	14,690	.03	13	44,628	.03
Ohio	14	8,299	.01	14	17,100	.01
Montana	15	2,475	1.20	15	7,425	.89
Other States [b]	.....	713,751		.....	1,153,140	
Total	.....	59,643,098	100.00	.....	130,905,558	100.00

[a] Colorado, Connecticut, Idaho, Maryland, Massachusetts, Mississippi, Nevada, and Texas.
[b] California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Nevada, North Carolina, Texas, West Virginia, and Wyoming.

Quantity and value of iron ore marketed in the United States, 1912 and 1913, by States.

State.	1912		1913		Increase (+) or decrease (−) in 1913.		Percentage of increase (+) or decrease (−) in 1913.	
	Quantity, in long tons.	Value.	Quantity, in long tons.	Value.	Quantity, in long tons.	Value.	Quantity.	Value.
Alabama	4,776,545	$5,734,371	5,333,218	$6,648,569	+ 556,673	+ $914,198	+ 11.65	+15.94
Georgia	135,337	227,282	153,336	237,876	+ 17,999	+ 10,594	+ 13.30	+ 4.66
Michigan	12,797,468	29,003,163	12,668,560	33,479,954	− 128,908	+ 4,476,791	− 1.01	+15.44
Minnesota	34,249,813	61,805,017	36,603,331	80,789,025	+2,353,518	+18,984,008	+ 6.87	+30.72
Missouri	42,120	92,996	37,134	83,628	− 4,986	− 9,368	− 11.84	−10.07
Montana	(a)	(a)	2,475	7,425	(a)	(a)	(a)	(a)
New Jersey	366,823	1,192,816	291,653	980,303	− 75,170	− 212,513	− 20.49	−17.82
New Mexico	(a)	(a)	164,085	148,405	(a)	(a)	(a)	(a)
New York	1,167,405	2,933,024	1,420,889	3,100,235	+ 253,484	+ 167,211	+ 21.71	+ 5.70
Ohio	20,861	40,986	8,299	17,100	− 12,562	− 23,886	− 60.22	−58.28
Pennsylvania	522,172	481,353	478,693	589,038	− 43,479	+ 107,685	− 8.33	+22.37
Tennessee	416,885	564,443	364,092	493,556	− 52,793	− 70,887	− 12.66	−12.56
Utah	7,280	22,686	14,690	44,628	+ 7,410	+ 22,042	+101.79	+97.59
Virginia	412,520	903,130	492,649	983,279	+ 80,129	+ 80,149	+ 19.42	+ 8.87
Wisconsin	1,152,260	2,731,574	896,243	2,149,397	− 256,007	− 582,177	− 22.22	−21.31
Other States b	950,135	1,317,412	713,751	1,153,140	− a 69,824	− a 8,442	− a 7.35	− a .64
Total	57,017,614	107,050,153	59,643,098	130,905,558	+2,625,484	+23,855,405	+ 4.60	+22.28

a Montana and New Mexico included with "Other States."
b 1912: California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Montana, Nevada, New Mexico, North Carolina, Texas, West Virginia, and Wyoming. 1913: California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Montana, Nevada, New Mexico, North Carolina, Texas, West Virginia, and Wyoming.

PRODUCTION OF IRON ORE, BY VARIETIES, BY STATES, AND MINING DISTRICTS.

Iron minerals are classified as sulphides, oxides, carbonates, silicates, etc., of which only the oxides and the carbonates are used in the iron and steel industry, except a very small quantity of by-product from sulphide ores used in acid manufacture. The ores of iron are generally classed under four heads:

1. *Hematite.*—Including all varieties of the anhydrous sesquioxide (Fe_2O_3—theoretical percentage of iron, 70). This is known locally as red hematite, specular ore, gray ore, fossil ore, oolitic ore, etc.

2. *Brown ore.*—Including hydrated sesquioxides, such as limonite, göthite, and turgite, or a mixture of these minerals ($Fe_2O_3nH_2O$—theoretical percentages of iron, 59.8—66.2). This is known locally as brown ore, brown hematite, bog ore, limonite, etc.

3. *Magnetite.*—Including magnetic oxides (Fe_3O_4—theoretical percentage of iron, 72.4). Magnetite is known generally as magnetic iron ore.

4. *Iron carbonate.*—Including carbonates of various types ($FeCO_3$—theoretical percentage of iron, 48.2). Iron carbonate is known locally as spathic iron ore, kidney ore, black-band ore, siderite, etc.

Hematite has always been predominant as an ore of iron, and at present constitutes more than nine-tenths of the iron ore produced in the United States. Brown ore and magnetite are far below it in importance; brown ore furnishes at present less than 3 per cent and magnetite a little less than 4 per cent of the total iron-ore production. The production of iron carbonate is insignificant in comparison with that of the other ores; in 1913 it constituted only about 0.045 per cent of the total.

In the following tables are shown the quantities of each of the classes of iron ores mined in the various States and mining districts during 1912 and 1913:

Iron ore mined in the United States in 1912 and 1913, by States and varieties, with percentage of increase or decrease in 1913, in long tons.

1912.

State.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total quantity.
Alabama	3,814,361	749,242	.....	.....	4,563,603
California	.....	.....	2,508	.....	2,508
Georgia	(a)	a 134,637	.....	.....	134,637
Kentucky	27,373	.....	.....	.....	27,373
Maryland	.....	3,200	.....	.....	3,200
Michigan	11,191,430	.....	.....	.....	11,191,430
Minnesota	b34,431,768	.....	.....	.....	34,431,768
Missouri	39,721	3,759	.....	.....	43,480
New Jersey	.....	.....	364,673	.....	364,673
New York	106,327	.....	1,110,345	.....	1,216,672
North Carolina	.....	.....	68,322	.....	68,322
Ohio	.....	.....	.....	10,346	10,346
Pennsylvania	10,557	30,371	476,153	.....	517,081
Tennessee	245,754	171,131	.....	.....	416,885
Texas	.....	3,000	.....	.....	3,000
Utah	.....	7,280	.....	.....	7,280
Virginia	47,472	398,833	.....	.....	446,305
West Virginia	.....	5,061	.....	.....	5,061
Wisconsin	860,600	.....	.....	.....	860,600
Other States c	562,219	116,172	157,532	.....	835,923
Total	51,345,782	1,614,486	2,179,533	10,346	55,150,147

a Hematite included in brown ore.
b Includes some brown ore and a little magnetic ore.
c Colorado, Connecticut, Idaho, Massachusetts, Montana, Nevada, New Mexico, and Wyoming.

1913.

State.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total quantity.	Percentage of increase (+) or decrease (−) in 1913.
Alabama	4,370,823	844,917	.....	.....	5,215,740	+ 14.29
California	.....	.....	2,092	.....	2,092	− 16.59
Georgia	59,076	96,160	.....	.....	155,236	+ 15.30
Kentucky	3,400	.....	.....	.....	3,400	− 87.58
Michigan	12,841,093	.....	.....	.....	12,841,093	+ 14.74
Minnesota	a38,658,793	.....	.....	.....	38,658,793	+ 12.28
Missouri	33,709	5,645	.....	.....	39,354	− 9.49
Montana	.....	2,475	.....	.....	2,475	(b)
New Jersey	.....	.....	325,305	.....	325,305	− 10.80
New Mexico	.....	.....	164,085	.....	164,085	(b)
New York	118,776	.....	1,340,852	.....	1,459,628	+ 19.97
North Carolina	.....	.....	69,235	.....	69,235	+ 1.34
Ohio	.....	.....	.....	7,849	7,849	− 24.13
Pennsylvania	(c)	c 34,041	455,015	.....	489,056	− 5.42
Tennessee	244,156	125,256	590	.....	370,002	− 11.25
Utah	.....	d 14,690	(d)	.....	14,690	+101.79
Virginia	129,686	354,157	.....	.....	483,843	+ 8.41
West Virginia	.....	7,808	.....	.....	7,808	+ 54.28
Wisconsin	1,018,272	.....	.....	.....	1,018,272	+ 18.32
Wyoming	537,111	.....	.....	.....	537,111	(b)
Other States e	.....	95,370	.....	20,000	115,370	− b 2.74
Total	58,018,295	1,577,019	2,357,274	27,849	61,980,437	+ 12.38

a Includes some brown ore and a little magnetic ore.
b Less than three producers in Montana, New Mexico, and Wyoming in 1912 and in Maryland and Texas in 1913, and permission was not granted to publish State totals. Increases and decreases in 1913, therefore, included in "Other States."
c Hematite included in brown ore.
d Magnetite included in brown ore.
e Colorado, Connecticut, Idaho, Maryland, Massachusetts, Mississippi, Nevada, and Texas.

Iron ore mined in the United States, by mining districts and varieties, in 1912 and 1913, with percentage of increase or decrease in 1913, in long tons.

1912.

District.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
Lake Superior[a]	46,368,878				46,368,878
Birmingham	3,537,433	420,310			3,957,743
Chattanooga	518,536	259,984			778,520
Adirondack			965,736		965,736
Northern New Jersey and southeastern New York			509,282		509,282
Other districts	920,935	934,192	704,515	10,346	2,569,988
Total	51,345,782	1,614,486	2,179,533	10,346	55,150,147

1913.

District.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.	Percentage of increase (+) or decrease (−) in 1913.
Lake Superior[a]	52,377,362				52,377,362	+12.96
Birmingham	4,159,837	442,736			4,602,573	+16.29
Chattanooga	491,770	216,849			708,619	− 8.98
Adirondack			1,214,704		1,214,704	+25.78
Northern New Jersey and southeastern New York			451,453		451,453	−11.36
Other districts	989,326	917,434	691,117	27,849	2,625,726	+ 2.17
Total	58,018,295	1,577,019	2,357,274	27,849	61,980,437	+12.38

[a] Includes only those mines in Wisconsin which are in the true Lake Superior district, and includes some brown ore and a little magnetic ore.

These tables show that the great bulk of the hematite comes from the Lake Superior district (Michigan, Minnesota, and Wisconsin) and Alabama, the bulk of the brown ore from the Appalachian States, and the magnetite from New York, New Jersey, and Pennsylvania. The iron carbonate is obtained from Ohio and Mississippi. On a later page is given the production of the principal ranges in the Lake Superior district. It is a well-known fact that the great bulk of the Lake Superior hematite is more or less hydrated, and that many deposits include masses of brown ore having varying percentages of combined water. There is, however, a complete gradation from anhydrous hematite to limonite, and since there is no sharp dividing line and since also the greater part of the ore is nearer the anhydrous than the completely hydrated condition, the production of the hydrated ores is included in the production of hematite. The ores mined in the Crystal Falls and Iron River areas of the Menominee Range are, on the whole, considered to be somewhat more hydrated than other ores of the Lake Superior district.[1] According to the analyses of Lake Superior iron ores given in Survey Monograph 52, pages 477–479, the average loss by ignition, which includes the combined water of the ore, was 4.12 per cent in 1909, and the range in percentage was between 0.40 and 11.40. Since the combined water in a true limonite is 14.4 per cent, it is seen that the ores as a whole fall well below the limonite content of water. Certain mines in northern Michigan produce an ore which is locally termed magnetite,

[1] Personal communication from C. K. Leith, Madison, Wis.

but which is a coarsely crystalline anhydrous ore consisting dominantly of hematite, but having sufficient quantities of magnetite distributed through it to render the ore strongly magnetic. This magnetic ore is also included with hematite in the production tables, both because it is not a true magnetite and because no provision is made for a class of magnetic ores.

TOTAL PRODUCTION OF IRON ORE.

In the following table is shown the production of various types of iron ore in the United States as far as has been recorded. The statistics from 1889 to the present were collected by the United States Geological Survey; those for 1860, 1870, and 1880 were collected for the census reports of those years; those for 1875 and 1881 were estimated by I. L. Bell;[1] and those from 1882 to 1888, inclusive, were estimated by James M. Swank[2] from the pig-iron production. No figures can be obtained for the production of various classes of iron ores prior to 1889, except for the census year 1880.

Iron ore mined in the United States, 1860–1913, in long tons.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
1860	.....	.....	.....	.....	2,873,460
1870	.....	.....	.....	.....	[a]3,831,891
1875	.....	.....	.....	.....	4,017,857
1880	2,243,993	1,918,622	2,134,276	823,471	7,120,362
1881	.....	.....	.....	.....	7,119,643
1882	.....	.....	.....	.....	[b]8,700,000
1883	.....	.....	.....	.....	[b]8,800,000
1884	.....	.....	.....	.....	[b]7,718,129
1885	.....	.....	.....	.....	[b]7,600,000
1886	.....	.....	.....	.....	[b]10,000,000
1887	.....	.....	.....	.....	[b]11,300,000
1888	.....	.....	.....	.....	[b]12,062,530
1889	9,056,288	2,523,087	2,506,415	432,251	14,518,041
1890	10,527,650	2,559,938	2,570,838	377,617	16,036,043
1891	9,327,398	2,757,564	2,317,108	189,108	14,591,178
1892	11,646,619	2,485,101	1,971,965	192,981	16,296,666
1893	8,272,637	1,849,272	1,330,886	134,834	11,587,629
1894	9,347,434	1,472,748	972,219	87,278	11,879,679
1895	12,513,995	2,102,358	1,268,222	73,039	15,957,614
1896	12,576,288	2,126,212	1,211,526	91,423	16,005,449
1897	14,413,318	1,961,954	1,059,479	83,295	17,518,046
1898	16,150,684	1,989,681	1,237,978	55,373	19,433,716
1899	20,004,399	2,869,785	1,727,430	81,559	24,683,173
1900	22,708,274	3,231,089	1,537,551	76,247	27,553,161
1901	24,006,025	3,016,715	1,813,076	51,663	28,887,479
1902	30,532,149	3,305,484	1,688,860	27,642	35,554,135
1903	30,328,654	3,080,399	1,575,422	34,833	35,019,308
1904	23,839,477	2,146,795	1,638,846	19,212	27,644,330
1905	37,567,055	2,546,662	2,390,417	21,999	42,526,133
1906	42,481,375	2,781,063	2,469,294	17,996	47,749,728
1907	46,060,486	2,957,477	2,679,067	23,589	51,720,619
1908	31,788,564	[c]2,620,390	[c]1,547,797	26,585	35,983,336
1909	46,208,640	[c]2,839,265	[c]2,229,839	16,527	51,294,271
1910	51,367,007	[c]2,993,744	[c]3,631,835	22,320	[d]57,014,906
1911	39,626,224	2,032,094	2,202,527	15,707	[d]43,876,552
1912	51,345,782	1,614,486	2,179,533	10,346	[d]55,150,147
1913	58,018,295	1,577,019	2,357,274	27,849	[d]61,980,437
Total	.....	.....	.....	.....	871,605,648

[1] Bell, I. L., Principles of the manufacture of iron and steel, p. 451, 1884.
[2] Mineral Resources U. S., 1882 to 1888.
[a] Includes ore produced by owners of blast furnaces, estimated by census at 800,000 tons.
[b] Figures given are for consumption of domestic ores. Total production for 1882, 1883, and 1884 is estimated as 9,000,000, 8,400,000, and 8,200,000 tons, respectively. See Mineral Resources U. S. for 1883 and 1884.
[c] Some brown ore included in magnetite.
[d] Beginning with 1910 ore sold for paint excluded from iron-ore production and included in metallic paint.

In the following table the production of iron ore in the United States is shown from 1810 to 1869, and by decades from 1870 to 1909.

The figures for the years previous to 1889 were calculated from the pig-iron production which included imported ore as well as domestic ore used.

Production of iron ore in the United States from 1810 to 1909, by decades, in long tons, and rate of increase.

Decade.	Quantity	Percentage of increase.
1810–1869	49,656,000	.....
1870–1879	44,570,527	.....
1880–1889	91,043,854	104.3
1890–1899	163,989,193	80.1
1900–1909	383,932,500	134.1

PRINCIPAL IRON-ORE MINES.

In 1913 there were 411 iron-ore mines active as compared with 382 mines in 1912, and 194 mines produced more than 50,000 long tons of iron ore each as compared with 170 mines in 1912. The largest quantity produced by any single mine in 1913 was 3,457,608 long tons of hematite, mined at the Hull Rust mine, near Hibbing, on the Mesabi Range, Minn. The Leonard mine, near Chisholm, Minn., also on the Mesabi Range, held the record in 1912 with an output of 2,633,285 long tons, but the output of this mine decreased slightly in 1913 and it ranked second, with a production of 2,354,632 long tons of hematite. Nine mines in Minnesota besides two in Michigan and one group in Alabama produced more than 1,000,000 tons each, as compared with nine mines in Minnesota and one group in Alabama in 1912. The largest producer in Michigan in 1913 was the Norrie group, which reported having mined 1,267,887 long tons of hematite. Permission has been granted to the Survey by the owners and operators of 172 of these large mines to publish their production, and these statistics are given in the following table:

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1913.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity mined.
					Long tons.
1	Hull-Rust	Minnesota	Hibbing	Hematite	3,457,608
2	Leonard	do	Chisholm	do	2,354,632
3	Red Mountain Group	Alabama	Bessemer	do	2,205,196
4	Sauntry-Alpena	Minnesota	Virginia	do	1,684,257
5	Uno	do	Hibbing	do	1,663,838
6	Adams	do	Eveleth	do	1,628,683
7	Mahoning	do	Hibbing	do	1,515,428
8	Fayal	do	Eveleth	do	1,357,574
9	Genoa	do	Gilbert	do	1,288,082
10	Norrie Group	Michigan	Ironwood	do	1,267,887
11	Newport	do	do	do	1,207,973
12	Canisteo	Minnesota	Coleraine	do	1,099,748
13	Hawkins	do	Nashwauk	do	947,548
14	Susquehanna	do	Hibbing	do	904,019
15	Hill	do	Mesaba	do	856,210
16	Shenango	do	Chisholm	do	808,940
17	Holman	do	Taconite	do	762,068
18	Dale	do	Hibbing	do	693,148
19	Chisholm	do	Chisholm	do	690,301
20	Grant	do	Buhl	do	687,987
21	Witherbee, Sherman & Co. (Inc.)	New York	Mineville	Magnetite	684,690
22	Spruce	Minnesota	Gilbert	Hematite	609,020
23	Stevenson	do	Hibbing	do	588,082
24	Woodward 1, 2, and 3	Alabama	Lipscomb	do	586,010
25	Burt	Minnesota	Hibbing	do	569,736
26	Leetonia	do	do	do	498,536
27	Pioneer	do	Ely	do	485,963
28	Commodore	do	Virginia	do	484,188
29	Sunrise	Wyoming	Sunrise	do	479,888
30	Cornwall	Pennsylvania	Miners Village	Magnetite	452,709

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1913—Continued.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity mined.
					Long tons.
31	Zenith	Minnesota	Ely	Hematite	432,644
32	Clark	do	Chisholm	do	423,867
33	Bristol	Michigan	Crystal Falls	do	406,360
34	Penn	do	Norway and Vulcan.	do	399,606
35	Kinney	Minnesota	Kinney	do	396,514
36	Virginia	do	Eveleth	do	391,109
37	Pewabic	Michigan	Iron Mountain	do	369,384
38	Utica	Minnesota	Hibbing	do	352,838
39	Chapin	Michigan	Iron Mountain	do	352,483
40	Miller	Minnesota	Aurora	do	350,757
41	Albany	do	Hibbing	do	349,968
42	Missabe Mountain	do	Virginia	do	321,835
43	Caspian	Michigan	Palatka	do	319,849
44	Whiteside	Minnesota	Buhl	do	301,796
45	Sliver	do	Virginia	do	301,680
46	Biwabik	Minnesota	Biwabik	do	300,900
47	Union	do	Virginia	do	296,808
48	Colby	Michigan	Bessemer	do	293,944
49	Corsica	Minnesota	Gilbert	do	268,293
50	Queen group	Michigan	Negaunee	do	282,999
51	Aurora	do	Ironwood	do	281,673
52	Mississippi	Minnesota	Keewatin	do	281,571
53	Sellers	do	Hibbing	do	268,070
54	Baltic (including Fogarty)	Michigan	Palatka	do	265,596
55	Montreal	Wisconsin	Hurley	do	252,094
56	Kennedy	Minnesota	Cuyuna	do	251,984
57	Harold	do	Hibbing	do	246,152
58	Mary Charlotte, Nos. 1 and 2	Michigan	Negaunee	do	244,948
59	Monroe-Tener	Minnesota	Chisholm	do	244,403
60	Lincoln	do	Virginia	do	241,570
61	Norman	do	do	do	234,719
62	Hudson	do	Aurora	do	234,231
63	Scranton	do	Hibbing	do	232,181
64	Cary	Wisconsin	Hurley	do	225,799
65	Webb	Minnesota	Hibbing	do	222,077
66	Port Henry, No. 21	New York	Mineville	Magnetite	221,709
67	Aragon	Michigan	Norway	Hematite	215,658
68	Armour No. 2	Minnesota	Crosby	do	213,309
69	Laura	do	Hibbing	do	212,241
70	Lake Superior	Michigan	Ishpeming	do	204,873
71	Sibley	Minnesota	Ely	do	204,217
72	Woodbridge	do	Buhl	do	196,415
73	Tobin	Michigan	Crystal Falls	do	192,900
74	Brunt	Minnesota	Mountain Iron	do	187,199
75	Songo	Alabama	Songo	do	184,118
76	Raimund No. 1	do	Bessemer	do	183,638
77	Riverton Group	Michigan	Iron River	do	180,368
78	Cambria	do	Negaunee	do	177,850
79	Zimmerman	do	Stambaugh	do	177,463
80	Mohawk	Minnesota	Aurora	do	174,758
81	Rolling Mill	Michigan	Negaunee	do	174,354
82	La Rue	Minnesota	Nashwauk	do	166,920
83	Pettit	do	Gilbert	do	166,043
84	Schley	do	do	do	162,990
85	Loretto	Michigan	Loretto	do	162,653
86	Ironton	do	Bessemer	do	161,123
87	Hiawatha	do	Iron River	do	157,171
88	Section 30	Minnesota	Ely	do	151,852
89	American-Boston	Michigan	Diorite	do	151,118
90	Elba	Minnesota	Gilbert	do	149,079
91	Osana	Michigan	Iron River	do	148,029
92	Steinman	Alabama	Steinman	do	147,313
93	Mace	Minnesota	Hibbing	do	146,643
94	Brown Mining Co	Tennessee	Cardiff	do	146,578
95	Bangor	Minnesota	Biwabik	do	146,427
96	Republic	Michigan	Republic	do	145,540
97	Richmond	do	Palmer	do	138,394
98	Hanna, A	Minnesota	Mountain Iron	do	138,147
99	Buckeye	Wisconsin	Commonwealth.	do	136,391
100	Chicagoan	Michigan	Iron River	do	132,771
101	Cavour	Minnesota	Virginia	do	130,249
102	Sunday Lake	Michigan	Wakefield	do	129,650
103	Davidson No. 1	do	Iron River	do	127,401
104	Greeley	Alabama	Greeley	Brown ore	127,006
105	Gilbert	Minnesota	Gilbert	Hematite	126,697
106	Hanna B	do	Mountain Iron	do	123,871
107	Chatham	Michigan	Iron River	do	123,032
108	Yale	do	Bessemer	do	120,131
109	Perkins	Minnesota	Aurora	do	120,012

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1913—Continued.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity mined.
					Long tons.
110	Raimund No. 2	Alabama	Bessemer	Hematite	117,556
111	Mayville	Wisconsin	Mayville	do	115,423
112	Adriatic	Minnesota	Mesaba	do	113,612
113	Hemlock and Michigan	Michigan	Amasa	do	109,470
114	Grace	Minnesota	Hibbing	do	107,795
115	Iroquois	do	Mountain Iron	do	106,935
116	Bray	do	Keewatin	do	105,417
117	Pearson	do	Nashwauk	do	104,180
118	Minorca	do	Virginia	do	103,625
119	Judd	do	do	do	103,495
120	Pennington	Minnesota	Crosby	do	101,136
121	Graham	do	Mesaba	do	100,516
122	Lake Angeline	Michigan	Ishpeming	do	99,883
123	Peters	New Jersey	Ringwood	Magnetite	99,199
124	Soudan	Minnesota	Soudan	Hematite	98,557
125	Clifford	Michigan	Iron Mountain	do	95,311
126	Armour No. 1	Minnesota	Crosby	do	93,333
127	Tilden	Michigan	Bessemer	do	92,956
128	Morrow	Minnesota	Eveleth	do	91,512
129	Crudup	Alabama	Gadsden	do	91,001
130	Castile	Michigan	Wakefield	do	90,376
131	Jim Fair	New Mexico	Fierro	Magnetite	90,022
132	Ravenna	Michigan	Crystal Falls	Hematite	89,821
133	Armenia	do	do	do	89,636
134	Bennett	Minnesota	Keewatin	do	88,931
135	Ironaton	Alabama	Ironaton	Brown ore	87,637
136	Madrid	Minnesota	Virginia	Hematite	86,053
137	Palms	Michigan	Bessemer	do	85,841
138	Agnew	Minnesota	Hibbing	do	84,444
139	Breitung Hematite No. 2	Michigan	Negaunee	do	82,368
140	Cyprus	Minnesota	Hibbing	do	82,121
141	Davidson No. 2	Michigan	Iron River	do	81,939
142	Savoy	Minnesota	Ely	do	79,782
143	Puritan	Michigan	Ironwood	do	78,471
144	Troy	Minnesota	Eveleth	do	74,053
145	Forbes	Michigan	Iron River	do	73,079
146	Asteroid	do	Ramsay	do	72,464
147	Fowler	Minnesota	Aurora	do	72,430
148	Myers	do	Chisholm	do	72,055
149	Brotherton	Michigan	Wakefield	do	71,978
150	Florence	Wisconsin	Florence	do	70,632
151	Ottawa	do	Hurley	do	70,139
152	Monica	Minnesota	Biwabik	do	69,522
153	Cranberry	North Carolina	Cranberry	Magnetite	69,235
154	Belgrade	Minnesota	Biwabik	Hematite	69,135
155	Atlantic	Wisconsin	Iron Belt	do	68,771
156	Raimund No. 3	Alabama	Bessemer	do	67,903
157	Houston	do	Rickey	Brown ore	67,815
158	Docray	do	Docray	do	67,771
159	Tannehill	do	Goethite	do	62,503
160	Ontario	New York	Ontario	Hematite	61,631
161	Snow Flake	New Mexico	Fierro	Magnetite	57,580
162	Chicago	Wyoming	Sunrise	Hematite	57,222
163	Morton	Minnesota	Hibbing	do	57,049
164	Friedman	Alabama	Woodstock	Brown ore	56,244
165	Berkshire	Michigan	Stambaugh	Hematite	56,200
166	Spaulding	Alabama	Birmingham	do	56,192
167	Attalla	do	Attalla	do	55,593
168	Franklin	Minnesota	Virginia	do	55,379
169	Cheever	New York	Port Henry	Magnetite	54,728
170	Allan	Minnesota	Virginia	Hematite	52,000
171	Virgil	Michigan	Iron River	do	51,824
172	Chandler	Minnesota	Ely	do	51,000
173	Estelle	Georgia	Estelle	do	50,686
174	Adams	Michigan	Ishpeming	do	50,012
	Total (174 mines)				55,456,131
	Unspecified (20 mines)[a]				3,501,763
	Tonnage from mines producing more than 50,000 long tons each				58,957,894
	Tonnage from mines producing less than 50,000 long tons each				3,022,543
	Grand total of United States				61,980,437

[a] Includes the product of 20 mines producing over 50,000 long tons each, operated by 8 companies, which do not permit the publication of individual figures.

STOCKS OF IRON ORE AT MINES.

According to the reports of producers, a few of which have been revised since the report for 1912 was published, the total quantity of iron ore in stock at the mines at the close of 1913 amounted to 12,918,633 long tons, compared with 10,624,662 tons at the close of 1912, an increase of 2,293,971 tons, or 21.59 per cent, which balances closely with the excess of mined over quantity shipped or used.

Since the tonnage of ore in stock piles is necessarily partly estimated, there are variations in the mine reports from year to year which prevent an absolutely accurate balance between the quantity mined and the quantity sold and stocks on hand. It is believed, however, that the figures presented in this report covering the years 1912 and 1913 are more nearly accurate than for any previous years.

Stock of iron ore on hand at the mines Dec. 31, 1911, 1912, and 1913, by States, in long tons.

State.	1911	1912	1913
Alabama	588,549	373,440	255,722
Colorado	.....	.....	1,000
Connecticut	.....	.....	265
Georgia	700	.....	1,800
Maryland	4,000	4,200	3,200
Massachusetts	5,461	1,013	3,400
Michigan	6,082,501	4,476,264	4,659,215
Minnesota	4,732,976	5,268,743	7,301,838
Mississippi	50	50	20,000
Missouri	1,140	1,720	4,190
New Jersey	124,080	125,946	160,894
New York	122,434	76,997	80,954
Ohio	16,440	4,344	3,894
Pennsylvania	34,416	25,923	36,551
Tennessee	8,955	9,234	15,144
Texas	24,600	25,600	27,600
Utah	5,425	230	130
Virginia	14,500	61,730	52,824
West Virginia	15,000	15,000	15,000
Wisconsin	425,163	154,228	275,012
Total	12,206,390	10,624,662	12,918,633
Percentage of increase in 1913	.....	.....	21.59

PRICES OF IRON ORE PER TON.

In the following table the price per ton of the different classes of iron ore in 1912 and 1913 is given for each of the producing States or groups of States, except where there were less than three producers of a certain variety of ore in a State whose total may be published, as in Georgia, Pennsylvania, Tennessee, and Utah. The total average prices per long ton (the whole United States considered) in 1913 were: Hematite, $2.21; brown ore, $1.83; magnetite, $2.07; carbonate, $2.06; as compared with prices, respectively, of $1.87, $1.79, $2.18, and $1.96 in 1912. These figures represent the value at the mines and are taken directly from statements of the producers. They are probably only approximately correct. The element of inaccuracy arises from the fact that by far the greater bulk of the iron ore produced in the United States is mined by pig-iron producers for their own furnaces, and the value placed on such ore is therefore largely a matter of accounting. Some of the reports made to the Survey evidently include merely actual mining costs; others contain, in addition, the cost of selling and insuring the ore; in others an allowance for sinking fund is included; and in still others the figures given are prices used in charging costs against the blast furnaces. At any rate, no freight costs are included.

The general average price of all kinds of iron ore in the United States was $2.19 in 1913, compared with $1.88 in 1912, an increase of 31 cents a ton, or 16.5 per cent. It is of interest to compare the prices given below with those of previous years and of the Lake Superior ores at the lower Lake ports given in subsequent tables.

Average price per long ton of iron ore marketed in the United States in 1912 and 1913, by States and varieties.

State.	Hematite.		Brown ore.		Magnetite.		Carbonate.	
	1912	1913	1912	1913	1912	1913	1912	1913
Alabama	$1.16	$1.18	$1.43	$1.61	.....	.....	.....	.....
Georgia	(a)	1.34	1.69	1.68	.....	.....	.....	.....
Michigan	2.27	2.64	.....	.....	.....	.....	.....	.....
Minnesota	1.80	2.21	.....	.....	.....	.....	.....	.....
Missouri	2.21	2.28	2.16	2.00	.....	.....	.....	.....
Montana	.....	.....	(b)	3.00	.....	.....	.....	.....
New Jersey	.....	.....	.....	.....	$3.25	$3.35	.....	.....
New Mexico	.....	.....	(b)	.90	.....	.....	.....	.....
New York	1.92	1.94	.....	.....	2.57	2.20	.....	.....
Ohio	.....	.....	.....	.....	.....	.....	$1.96	$2.06
Pennsylvania	2.33	(a)	2.46	2.70	.79	(a)	.....	.....
Tennessee	1.27	1.27	1.47	1.52	.....	(a)	.....	.....
Utah	.....	.....	3.10	(a)	.....	(a)	.....	.....
Virginia	1.62	2.35	2.26	1.85	.....	.....	.....	.....
Wisconsin	2.37	2.40	.....	.....	.....	.....	.....	.....
Other States c	1.01	1.04	2.83	3.68	1.52	3.03	.....	.....
Total average	1.87	2.21	1.79	1.83	2.18	2.07	1.96	2.06

a Less than three producers; therefore, price may not be shown.
b Included in "Other States."
c 1912: California, Colorado, Connecticut, Idaho, Kentucky, Maryland, Massachusetts, Montana, Nevada, New Mexico, North Carolina, Texas, West Virginia, and Wyoming. 1913: California Colorado, Connecticut, Idaho, Kentucky, Maryland Massachusetts, Nevada, North Carolina, Texas, West Virginia, and Wyoming.

The next table gives the general average price per ton of all iron ores produced in the United States in 1889 and since 1892, and also the average price by varieties of ore since 1906:

Average price per long ton of iron ore in the United States, 1889 and 1892 to 1913, by varieties.

Year.	Hematite.	Brown ore.	Magnatite.	Carbonate.	General average.
1889	.....	.....	.....	.....	$2.30
1892	.....	.....	.....	.....	2.04
1893	.....	.....	.....	.....	1.66
1894	.....	.....	.....	.....	1.14
1895	.....	.....	.....	.....	1.14
1896	.....	.....	.....	.....	1.42
1897	.....	.....	.....	.....	1.08
1898	.....	.....	.....	.....	1.14
1899	.....	.....	.....	.....	1.42
1900	.....	.....	.....	.....	2.42
1901	.....	.....	.....	.....	1.71
1902	.....	.....	.....	.....	1.84
1903	.....	.....	.....	.....	1.89
1904	.....	.....	.....	.....	1.56
1905	.....	.....	.....	.....	1.77
1906	$2.13	$1.78	$2.05	$1.75	2.11
1907	2.63	1.81	2.03	1.74	2.55
1908	2.32	1.70	2.40	1.38	2.27
1909	2.17	1.68	2.40	1.73	2.15
1910	2.52	1.76	2.36	1.61	2.47
1911	2.12	1.72	2.29	1.83	2.11
1912	1.87	1.79	2.18	1.96	1.88
1913	2.21	1.83	2.07	2.06	2.19

APPARENT IRON-ORE CONSUMPTION COMPARED WITH PIG-IRON PRODUCTION.

The following table includes data on certain items from which an approximate estimate of the annual consumption of iron ore in the United States is deduced. The result is, of course, merely an approximation, for no data are available on certain other items which should enter into the final result. The items considered in the table and estimates for all years preceding 1911 are (1) domestic iron-ore production; (2) stocks of ore at mines for current year and past year; (3) stocks of ore at lower Lake ports for current year and past year; (4) zinc residuum production; (5) imports of ore; (6) exports of ore. Beginning with 1911 the shipments of ore became available, and these figures together with zinc residuum, and the imports constitute the available supply, which, less the exports, gives the apparent consumption, without consideration of the stocks at mines and Lake ports.

In the same table is included the production of pig iron for corresponding years and the percentage ratio of pig iron produced to iron ore consumed. The pig iron figures are introduced here merely for comparison. On later pages of the report will be found detailed data on the production and shipments of pig iron.

Apparent consumption of iron ore compared with production of pig iron in the United States, 1889–1913, in long tons.

Year.	Domestic iron ore produced.[a]	Stocks of ore at mines.	Stocks of ore at lower Lake ports Dec. 1.	Zinc residuum.	Imports.	Exports.	Apparent consumption.	Pig iron produced.[b]	Percentage ratio of pig iron to iron ore.
1889	14,518,041	2,256,973	2,607,106	43,648	853,573	.....	14,366,562	7,603,642	52.93
1890	16,036,043	2,000,000	3,893,487	48,560	1,246,830	.....	16,302,025	9,202,703	56.45
1891	14,591,178	2,450,279	3,508,489	38,228	912,864	.....	15,476,989	8,279,870	53.50
1892	16,296,666	2,911,740	4,149,451	31,859	806,585	.....	16,032,687	9,157,000	57.11
1893	11,587,629	3,526,161	4,070,710	37,512	526,951	.....	11,616,412	7,124,502	61.33
1894	11,879,679	3,236,198	4,834,247	26,981	167,307	.....	11,600,393	6,657,388	57.39
1895	15,957,614	2,976,494	4,415,712	43,249	524,153	.....	17,203,255	9,446,308	54.91
1896	16,005,449	3,405,302	4,954,984	44,953	682,806	.....	15,765,128	8,623,127	54.70
1897	17,518,046	3,098,287	5,923,755	33,924	489,970	.....	17,380,184	9,652,680	55.54
1898	19,433,716	2,846,457	5,136,407	48,502	187,208	.....	20,708,604	11,773,934	56.86
1899	24,683,173	2,320,278	5,530,283	65,010	674,082	40,665	25,513,903	13,620,703	53.39
1900	27,553,161	3,709,950	5,904,670	87,110	897,831	51,460	26,722,583	13,789,242	51.60
1901	28,887,479	4,239,823	5,859,663	52,311	966,950	64,703	29,357,171	15,878,354	54.09
1902	35,554,135	3,834,717	7,074,254	65,246	1,165,470	88,445	35,886,921	17,821,307	49.66
1903	35,019,308	6,297,888	6,371,085	73,264	980,440	80,611	34,232,399	18,009,252	52.61
1904	27,644,330	4,666,931	5,763,399	68,189	487,613	213,865	30,224,910	16,497,033	54.58
1905	42,526,133	3,812,281	6,438,967	90,289	845,651	208,017	43,433,138	22,992,380	52.94
1906	47,749,728	3,281,789	6,252,455	93,461	1,060,390	265,240	49,355,343	25,307,191	51.28
1907	51,720,619	3,033,110	7,385,728	93,413	1,229,168	278,608	51,879,998	25,781,361	49.69
1908	35,983,336	6,065,397	8,441,533	110,225	776,898	309,099	32,473,268	15,936,018	49.74
1909	51,294,271	6,135,271	8,965,789	141,264	1,694,957	455,934	52,080,428	25,795,471	49.53
1910	57,014,906	9,422,285	9,426,881	137,173	2,591,031	748,875	55,246,129	27,303,567	49.42
1911[c]	41,092,447	.....	.....	109,296	1,811,732	768,386	42,245,089	23,649,547	55.98
1912[c]	57,017,614	.....	.....	104,670	2,104,576	1,195,742	58,031,118	29,726,937	51.23
1913[c]	59,643,098	.....	.....	102,239	2,594,770	1,042,151	61,297,956	30,966,152	50.52

[a] Beginning with 1910, iron ore sold for paint excluded from production and included in metallic paint.

[b] From annual reports of the American Iron and Steel Association prior to 1912, and including ferroalloys produced in blast furnaces; beginning with 1912, according to American Iron and Steel Institute, and also including ferroalloys.

[c] Beginning with 1911, figures represent shipments.

IRON-ORE INDUSTRY IN THE LAKE SUPERIOR DISTRICT.

Production of iron ore in the Lake Superior district, by ranges.—The Lake Superior district includes the Vermilion, Mesabi, Cuyuna, Penokee-Gogebic, Marquette, and Menominee ranges in the States of Minnesota, Michigan, and Wisconsin. The Menominee range includes the Crystal Falls, Metropolitan, Iron River, and Florence areas; the Marquette range includes the Republic and Swanzy areas. The Baraboo and Iron Ridge areas of southern Wisconsin and the Spring Valley area of northwestern Wisconsin are frequently also included in the Lake Superior district. In the first group of ranges the ore mined is almost entirely Algonkian hematite, belonging to the Huronian series. The Baraboo ore is of the same nature, but the Iron Ridge ore is "Clinton" hematite, and the Spring Valley ore is brown ore.

In addition to these ranges, there are several iron-ore districts on the Canadian side of the Great Lakes, the principal ones of which are the Michipicoten, the Animikie, the Matawin, and the Atikokan, the production of which, of course, is not included in these statistics.

The ranges in the United States which produced ore in 1913 were the Vermilion, Mesabi, Penokee-Gogebic, Marquette, Menominee, and Cuyuna, besides the Iron Ridge area. Much development work was done on the Cuyuna range, which made its first shipments in 1911.

An analysis of reported production (quantity mined) in 1913, by ranges, in the Lake Superior district, shows that the Mesabi range mined 36,378,671 tons of iron ore, compared with 32,604,756 tons in 1912, an increase of 11.57 per cent; the Menominee range 4,997,246 tons, compared with 4,465,466 tons in 1912, an increase of 11.91 per cent; the Gogebic range 4,743,515 tons, compared with 3,926,632 tons in 1912, an increase of 20.80 per cent; the Marquette range 3,977,808 tons, compared with 3,545,012 tons in 1912, an increase of 12.21 per cent; the Vermilion range 1,536,115 tons, compared with 1,457,273 tons in 1912, an increase of 5.41 per cent; and the Cuyuna range, which in 1913 entered upon its third year as a shipper of ore, 744,007 tons, compared with 369,739 tons in 1912, an increase of 101.22 per cent.

The Mesabi range produced 69.46 per cent of the entire Lake Superior output and nearly 59 per cent of the entire production of the United States. The Menominee, Penokee-Gogebic, and Marquette ranges are next in importance, the Menominee producing in 1913 about 200,000 lons less than the State of Alabama, which is the next State in importance as a producer after Minnesota and Michigan. The Vermilion range, the fifth in importance of the six producing Lake Superior ranges, produced more ore in 1913 than New York, which is fourth in importance as a producing State.

The following table shows the production of the first six of these ranges for 1912 and 1913, as they constitute the Lake Superior district proper:

Production of iron ore (quantity mined) in the Lake Superior region,[a] 1912–13, by ranges, in long tons.

Range.	1912	1913	Increase in 1913.	Percentage of increase in 1913.	Percentage of total production in Lake Superior region, 1913.
Marquette (Michigan)	3,545,012	3,977,808	432,796	12.21	7.59
Menominee (Michigan and Wisconsin)	4,465,466	4,997,246	531,780	11.91	9.54
Gogebic (Michigan and Wisconsin)	3,926,632	4,743,515	816,883	20.80	9.06
Vermilion (Minnesota)	1,457,273	1,536,115	78,842	5.41	2.93
Mesabi (Minnesota)	32,604,756	36,378,671	3,773,915	11.57	69.46
Cuyuna (Minnesota)	369,739	744,007	374,268	101.22	1.42
Total	46,368,878	52,377,362	6,008,484	12.96	100.00

[a] Includes only such Wisconsin mines as are in the true Lake Superior district.

In the following table is shown the total production of the Lake Superior district by ranges. The figures prior to 1872 were collected by A. P. Swineford, editor Marquette Mining Journal;[1] those for 1872 to 1877, inclusive, are from the Michigan Mineral Statistics; those from 1878 to 1888, inclusive, were collected by W. J. Stevens;[2] and the later figures were collected by the United States Geological Survey.

Production of Lake Superior iron ore, 1854–1913, by ranges, in long tons.

Year.	Marquette.	Menominee.	Gogebic.	Vermilion.	Mesabi.	Cuyuna.	Total.
1854–1869	3,112,209						3,112,209
1870	859,507						859,507
1871	813,984						813,984
1872	948,553						948,553
1873	1,195,234						1,195,234
1874	899,934						899,934
1875	881,166						881,166
1876	993,311						993,311
1877	1,014,754	10,375					1,025,129
1878	1,033,082	78,028					1,111,110
1879	1,130,019	245,672					1,375,691
1880	1,384,010	524,735					1,908,745
1881	1,579,834	726,671					2,306,505
1882	1,829,394	1,136,018					2,965,412
1883	1,305,364	1,047,863					2,353,227
1884	1,559,912	895,634	1,022	62,122			2,518,690
1885	1,430,862	690,435	119,590	227,075			2,467,962
1886	1,627,383	880,006	756,237	307,948			3,571,574
1887	1,851,717	1,199,343	1,285,265	394,910			4,731,235
1888	1,918,672	1,191,097	1,433,689	511,953			5,055,411
1889	2,631,026	1,876,157	2,147,923	864,508			7,519,614
1890	2,863,848	2,274,192	2,914,081	891,910			8,944,031
1891	2,778,482	1,856,124	2,041,754	945,105			7,621,465
1892	2,848,552	2,402,195	3,058,176	1,226,220	29,245		9,564,388
1893	2,064,827	1,563,049	1,466,815	815,735	684,194		6,594,620
1894	1,935,379	1,255,255	1,523,451	1,055,229	1,913,234		7,682,548
1895	1,982,080	1,794,970	2,625,475	1,027,103	2,839,350		10,268,978
1896	2,418,846	1,763,235	2,100,398	1,200,907	3,082,973		10,566,359
1897	2,673,785	1,767,220	2,163,088	1,381,278	4,220,151		12,205,522
1898	2,987,930	2,275,664	2,552,205	1,125,538	4,837,971		13,779,308
1899	3,364,596	3,281,422	2,725,648	1,643,984	6,517,305		17,802,955
1900	3,945,068	3,680,738	3,104,033	1,675,949	8,158,450		20,564,238
1901	3,597,089	3,697,408	3,041,869	1,805,996	9,303,541		21,445,903
1902	3,734,712	4,421,250	3,683,792	2,057,532	13,080,118		26,977,404
1903	3,686,214	4,093,320	3,422,341	1,918,584	13,452,812		26,573,271
1904	2,465,448	2,871,130	2,132,898	1,056,430	11,672,405		20,198,311
1905	3,772,645	4,472,630	3,344,551	1,578,626	20,156,566		33,325,018
1906	4,070,914	4,962,357	3,484,023	1,794,186	23,564,891		37,876,371
1907	4,167,810	4,779,592	3,609,519	1,724,217	27,245,441		41,526,579
1908	3,309,917	2,904,011	3,241,931	927,206	17,725,014		28,108,079
1909	4,291,967	4,789,362	3,807,157	1,097,444	27,877,705		41,863,635
1910	4,631,427	4,983,729	4,746,818	1,390,360	30,576,409		46,328,743
1911	3,743,145	4,062,778	3,099,197	1,336,938	23,126,943	181,224	35,550,225
1912	3,545,012	4,465,466	3,926,632	1,457,273	32,604,756	369,739	46,368,878
1913	3,977,808	4,997,246	4,743,515	1,536,115	36,378,671	744,007	52,377,362
Total	109,127,428	89,916,377	78,303,093	35,038,381	319,048,145	1,294,970	632,728,394

[1] U. S. Geol. Survey Mineral Resources, 1882, p. 116, 1883.

[2] Idem, 1891, p. 39–41, 1893.

Shipments and receipts of Lake Superior iron ore.—According to the Iron Trade Review, 49,947,116 long tons of iron ore were shipped in 1913 from the Lake Superior district, including the Iron Ridge area in Wisconsin, compared with 48,221,546 tons in 1912. Of the 1913 total 876,638 tons were shipped by rail, the remainder being by boat; 785,769 tons were shipped by rail in 1912. The shipments from the Lake Superior iron-ore ranges and the Iron Ridge area as reported to the Survey in 1913 amounted to 50,168,134 long tons. This quantity agrees within 0.44 per cent with the tonnage published by the Iron Trade Review.

The following tables give the details of shipments and receipts of Lake Superior iron ore by ports for the last six years:

Shipments of Lake Superior iron ore, 1908–1913, in long tons.[a]

Shipping port.	1908	1909	1910	1911	1912	1913
Escanaba, Mich.	3,351,502	5,747,801	4,959,726	4,278,445	5,234,655	5,399,444
Marquette, Mich.	1,487,487	2,909,451	3,248,516	2,200,380	3,296,761	3,132,716
Ashland, Wis.	2,513,670	3,834,207	4,094,374	2,429,290	4,797,101	4,338,230
Two Harbors, Minn.	5,702,237	9,181,132	8,271,177	6,367,537	9,370,969	10,075,718
Superior, Wis.	3,564,030	6,540,505	8,414,799	9,920,490	14,240,714	13,788,343
Duluth, Minn.	8,808,168	13,470,503	13,640,166	6,934,269	10,495,577	12,331,126
Total by Lake	25,427,094	41,683,599	42,628,758	32,130,411	47,435,777	49,070,478
Total by rail	587,893	903,270	813,639	662,719	785,769	876,638
Total	26,014,987	42,586,869	43,442,397	32,793,130	48,221,546	49,947,116

[a] Iron Trade Review.

Iron-ore receipts at Lake Erie ports, 1908–1913, in long tons.[a]

Port.	1908	1909	1910	1911	1912	1913
Toledo	680,553	1,374,224	1,225,202	493,345	1,405,023	1,084,215
Sandusky		11,088				
Huron	213,377	243,082	197,951	223,947	540,586	687,485
Lorain	2,286,388	2,796,856	2,884,738	2,937,605	3,771,350	3,709,213
Cleveland	4,240,816	6,051,342	6,344,943	4,584,211	7,914,836	8,812,583
Fairport	1,518,961	1,734,277	1,516,434	666,365	1,810,381	2,037,126
Ashtabula	3,012,064	8,056,941	9,620,638	6,359,131	8,158,080	8,336,126
Conneaut	4,798,631	7,007,834	6,309,548	6,931,278	7,839,831	7,849,303
Erie	828,602	1,235,057	942,592	289,400	547,067	713,904
Buffalo	2,835,099	5,002,235	4,704,439	2,802,976	5,060,642	5,506,691
Detroit	112,561	159,889	296,412	243,292	418,057	363,001
Total	20,527,052	33,672,825	34,042,897	25,531,550	37,465,853	39,099,647

[a] Trade Iron Review.

The difference between the shipments of Lake Superior ore and the receipts at Lake Erie ports is accounted for mainly by the quantity of ore delivered at Lake Michigan ports, South Chicago, Ill., Gary and Indiana Harbor, Ind., and Milwaukee, Wis., the receipts at which ports and at a number of smaller places are shown in the table following. It is understood that there is also a loss, approximating 1 per cent, in handling ore between mines and lower Lake ports.

Iron-ore receipts at Lake Michigan ports, 1910–1913, in long tons.[a]

Port.	1910	1911	1912	1913
Elk Rapids, Mich.	60,857	26,814	47,947	.....
East Jordan, Mich.	37,910	36,232	42,878	28,444
Milwaukee, Wis.	121,446	109,255	138,065	234,591
Gary, Ind.	1,775,880	1,302,745	2,088,327	2,365,551
Indiana Harbor, Ind.	287,172	365,312	514,748	455,252
South Chicago, Ill.	5,080,679	3,685,100	5,480,105	5,572,866
Boyne City, Mich.	50,355	33,000	45,000	45,028
Fruitport, Mich.	37,785	.....	.....	.....
Total	7,452,084	5,558,458	8,357,070	8,701,732

[a] Iron Trade Review.

The following table shows the total quantity of iron ore shipped from the Lake Superior district since 1854, the date of the opening of the Marquette range, the oldest of the Lake Superior ranges. This table gives the shipments as published by the Iron Trade Review and is inserted for comparison with the table giving the total production of the Lake Superior district, without regard to shipments:

Shipments of iron ore from the Lake Superior region, 1854–1913, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1854	3,000	1875	891,257	1896	9,934,828
1855	1,449	1876	992,764	1897	12,469,638
1856	36,343	1877	1,015,087	1898	14,024,673
1857	25,646	1878	1,111,110	1899	18,251,804
1858	15,876	1879	1,375,691	1900	19,059,393
1859	68,832	1880	1,908,745	1901	20,589,237
1860	114,401	1881	2,306,505	1902	27,571,121
1861	49,909	1882	2,965,412	1903	24,289,878
1862	124,169	1883	2,353,288	1904	21,822,839
1863	203,055	1884	2,518,692	1905	34,384,116
1864	243,127	1885	2,466,372	1906	38,565,762
1865	236,208	1886	3,568,022	1907	42,266,668
1866	278,796	1887	4,730,577	1908	26,014,987
1867	473,567	1888	5,063,693	1909	42,586,869
1868	491,449	1889	7,292,754	1910	43,442,397
1869	617,444	1890	9,012,379	1911	32,793,130
1870	830,940	1891	7,062,233	1912	48,221,546
1871	779,607	1892	9,069,556	1913	49,947,116
1872	900,901	1893	6,060,492		
1873	1,162,458	1894	7,748,932	Total	623,755,334
1874	919,557	1895	10,429,037		

Stocks of iron ore at Lake Erie ports.—The following tables contain data as to the stocks of iron ore at the Lake Erie ports at the close of navigation and at the opening of navigation for the last six years:

Stocks of iron ore at lower Lake ports, Dec. 1, 1908–1913, in long tons.[a]

Port.	At close of navigation, Dec. 1—					
	1908	1909	1910	1911	1912	1913
Toledo, Ohio	590,925	332,456	433,215	661,382	552,016	349,047
Sandusky, Ohio	36,079	39,557	17,728	2,471	2,472	2,472
Huron, Ohio	458,158	477,333	375,118	344,371	385,810	441,541
Lorain, Ohio	426,274	407,129	259,448	314,321	320,713	694,704
Cleveland, Ohio	1,458,392	1,547,142	1,638,795	1,589,491	1,888,560	1,930,720
Fairport, Ohio	835,821	867,640	839,970	636,566	565,920	478,014
Ashtabula, Ohio	2,293,531	2,594,359	3,287,816	3,295,862	3,350,553	3,202,807
Conneaut, Ohio	1,296,675	1,411,002	1,329,997	1,237,573	1,429,533	1,248,032
Erie, Pa.	730,530	788,046	792,011	636,274	661,330	594,613
Buffalo, N. Y.	315,148	501,125	452,783	413,353	340,261	319,726
Total	8,441,533	8,965,789	9,426,881	9,131,664	9,497,168	9,261,676

[a] Iron Trade Review.

Stocks of iron ore at lower Lake ports, May 1, 1909–1914, in long tons.[a]

Port.	At opening of navigation, May 1—					
	1909	1910	1911	1912	1913	1914
Toledo, Ohio	380,675	366,631	383,761	356,102	394,984	215,534
Sandusky, Ohio	31,528	22,468	11,458	2,471	2,485	2,741
Huron, Ohio	379,364	336,693	273,042	257,496	293,006	308,478
Lorain, Ohio	362,096	205,445	346,849	287,294	399,705	245,057
Cleveland, Ohio	1,018,055	985,725	1,476,278	1,363,696	1,428,306	1,487,292
Fairport, Ohio	562,679	541,299	633,485	381,705	357,995	245,038
Ashtabula, Ohio	1,392,430	1,444,102	2,255,066	2,108,749	2,105,817	2,187,622
Conneaut, Ohio	497,203	461,365	419,421	229,462	135,100	495,153
Erie, Pa	557,029	550,187	653,778	585,150	449,455	461,750
Buffalo, N. Y	189,209	364,336	325,356	309,120	139,624	271,492
Total	5,370,268	5,278,251	6,778,494	5,881,245	5,706,477	5,920,157

[a] Iron Trade Review.

Prices of Lake Superior iron ore.—In the following table are given the prices of Lake Superior iron ore at the lower Lake ports from 1890 to 1914, according to the Iron Trade Review.

The base for the Bessemer ore is a metallic iron content of 55 per cent; that of the non-Bessemer ore is a metallic iron content of 51.5 per cent:

Selling price of iron ore at lower Lake ports, 1890–1914, at date of buying movement.[a]

Season.	Date buying movement.	Season iron-ore prices.			
		Old range Bessemer.	Mesabi Bessemer.	Old range non-Bessemer.	Mesabi non Bessemer.
1890	Dec. 15, 1889	$5.50	No sale.	$5.25	No sale.
1891	June 1, 1891	4.50	No sale.	4.25	No sale.
1892	Jan. 31, 1892	4.50	No sale.	3.65	No sale.
1893	Mar. 15, 1893	3.85	$3.00	3.20	No sale.
1894	Mar. 1, 1894	2.75	2.35	2.50	No sale.
1895	Apr. 1, 1895	2.90	2.15	2.25	$1.90
1896	May 1, 1896	4.00	3.50	2.70	2.25
1897	May 20, 1897	2.60	2.25	2.15	1.90
1898	Mar. 20, 1898	2.75	2.25	1.85	1.75
1899	Feb. 1, 1899	3.00	2.40	2.15	2.00
1900	Dec. 15, 1899	5.50	4.50	4.25	4.00
1901	Apr. 15, 1901	4.25	3.25	3.00	2.75
1902	Feb. 1, 1902	4.25	3.25	3.25	2.75
1903	Mar. 20, 1903	4.50	4.00	3.60	3.20
1904	Apr. 15, 1904	3.25	4.00	2.75	2.50
1905	Feb. 1, 1905	3.75	3.50	3.20	3.00
1906	Dec. 5, 1905	4.25	4.00	3.70	3.50
1907	Nov. 5, 1906	5.00	4.75	4.20	4.00
1908	June 15, 1908	4.50	4.25	3.70	3.50
1909	May 10, 1909	4.50	4.25	3.70	3.50
1910	Dec. 24, 1909	5.00	4.75	4.20	4.00
1911	Apr. 21, 1911	4.50	4.25	3.70	3.50
1912	Mar. 20, 1912	3.75	3.50	3.00	2.85
1913	Nov. 19, 1912	4.40	4.15	3.60	3.40
1914	May 1, 1914	3.75	3.50	3.00	2.85

[a] Iron Trade Review.

Iron content of Lake ores.—Comparative data on the variation of average iron content in shipments of Lake Superior iron ores are of considerable economic value, and fortunately a brief article bearing on this subject is at hand.[1] A noteworthy decline in the average iron content is apparent, but it probably would be still greater at the present time had it not been checked to some extent by the employment of methods of beneficiation of ore that have been introduced

[1] Iron content of lake ores: Iron Age, p. 1096, Apr. 30, 1914.

in recent years at a number of mines. The following data were compiled by W. L. Tinker, secretary of the Lake Superior Iron Ore Association, Cleveland, Ohio. They show the average iron content of the ores shipped from the several ranges in 1913 and similar statistics for 1912 and 1902, together with the percentage of Bessemer shipments from the ranges for these years. The Iron Age states:

Below are presented Mr. Tinker's figures for total shipments, for average iron content (natural), and percentage of Bessemer ore for the years 1913, 1912, and 1902. It will be seen that there was a small decrease in average iron content last year, though 1912 showed an increase upon 1911, after a practically continuous decrease since 1902. The net average decrease in 1913 for all ranges, which was 0.33 per cent is not as large as might be expected from the large tonnage shipped and taking into consideration the fact that the percentage of lean ores is much greater when the mines are shipping well up to the maximum than when production is somewhat curtailed. The tables below take no account of the low-grade, siliceous, and manganiferous ores, only Bessemer and non-Bessemer grades being considered. A feature of the table is the great decline in the percentage of Bessemer ore shipped last year as compared with 1902. This is particularly noticeable on the Mesaba range.

Shipments of Bessemer and non-Bessemer ores from principal lake Superior iron ranges, in 1902, 1912, and 1913, in long tons.

Range.	Year.	Bessemer ores.			Non-Bessemer ores.	
		Tons.	Average percentage iron (natural).	Percentage Bessemer.	Tons.	Average percentage iron (natural).
Gogebic	1913	2,866,116	54.2071	68.0	1,345,784	53.0517
	1912	3,026,430	54.2386	64.1	1,691,851	53.2912
	1902	2,796,545	55.7324	87.5	397,726	53.7872
Marquette	1913	503,948	53.3717	14.3	3,024,893	52.7030
	1912	540,826	54.9180	15.0	3,058,000	52.7308
	1902	1,054,757	58.2631	29.9	2,464,187	55.1032
Menominee	1913	107,837	55.3393	3.0	3,527,423	50.8530
	1912	85,389	55.2117	2.5	3,252,805	51.0527
	1902	86,018	57.7141	2.8	2,919,762	54.1020
Vermilion	1913	1,200,674	58.8072	77.6	347,158	58.6264
	1912	1,369,602	59.3095	74.9	457,332	58.7775
	1902	1,639,108	61.5522	80.1	406,784	61.9984
Total old ranges	1913	4,678,575	55.3237	36.2	8,245,258	52.2179
	1912	5,022,247	55.7112	37.2	8,459,988	52.5245
	1902	5,576,428	57.9523	47.4	6,188,459	54.9995
Mesaba	1913	13,877,060	53.2644	41.5	19,584,395	49.3445
	1912	13,996,278	53.2513	45.3	16,886,587	49.4922
	1902	10,618,878	56.6690	80.6	2,546,936	53.5531
Total ores	1913	18,555,635	53.7836	40.0	27,829,653	50.1958
	1912	19,018,525	53.9009	41.9	25,346,575	50.5043
	1902	16,195,306	57.1109	64.9	8,735,395	54.5778

Total of Bessemer and non-Bessemer ores.

	Tons.	Average percentage (natural).
Old ranges:		
1913	12,923,833	53.3422
1912	13,482,235	53.7116
1902	11,764,887	56.3991
Mesaba:		
1913	33,461,455	50.9701
1912	30,882,865	51.1958
1902	13,165,814	56.0663

Total Bessemer and non-Bessemer, all ranges.

1913	46,385,288	51.6311
1912	44,365,100	51.9603
1902	24,930,701	56.2233

BARABOO AREA.

The following discouraging note concerning the Baraboo area, a once promising but never successfully developed ore field, has been published recently.[1]

After having expended large sums of money in a futile endeavor to develop a profitable producer, the United States Steel Corporation is withdrawing from the Baraboo field of Wisconsin. Its mine at North Freedom is being dismantled. With the pumps and the other machinery removed, the property will be abandoned. It is at this mine that the last operations in the field were conducted. Other tracts tested had previously fallen by the wayside.

A few years ago it appeared probable the Baraboo country would vie with some of the districts of the Lake Superior region as a source of iron supply. Exploration with the diamond drill had shown the existence of ore, and it was surmised that with shafts put down and lateral development undertaken the deposits would be found satisfactory in quantity and quality. The entry of the Steel Corporation was hailed as an event of great significance. But the district has not come up to expectations. Not only is the ore liberally mixed with rock, but water is present in such abundance as to make operations decidedly expensive. On one level at its North Freedom Mine the Steel Corporation had in commission no less than nine pumps. So wet is the sandstone formation that it is estimated that with the machinery stopped the property will fill with water within a hundred minutes. Threatened adverse taxation legislation also discouraged the operators.

FOREIGN TRADE IN IRON ORE.

IMPORTS.

The quantity of iron ore imported into the United States in 1913 was 2,594,770 long tons, valued at $8,336,819, or $3.21 a ton. This represents an increase in quantity of 490,194 tons, 23.29 per cent, and in value of $1,837,129, 28.26 per cent, as compared with the imports during 1912, which were 2,104,576 long tons, valued at $6,499,690, or $3.09 per ton. As to the source of the imports in 1913, Cuba produced approximately 63 per cent of the ore, Sweden 14 per cent, Newfoundland and Labrador 8 per cent, Canada 7 per cent, Spain 4.3 per cent, with minor quantities from Venezuela, French Africa, United Kingdom, Greece, Egypt, Germany, and other countries.

The statistics of imports of iron ore are furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce, and the following table gives the imports from the various countries from 1910 to 1913:

Quantity and value of iron ore imported into the United States in the calendar years 1910–1913, by countries, in long tons.

Country.	1910		1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cuba	1,451,096	$4,459,789	1,147,879	$3,218,485	1,398,593	$3,969,986	1,635,622	$4,864,186
Spain	439,868	1,040,589	194,965	502,453	92,061	222,951	112,580	488,798
French Africa	15,471	36,791	4,443	13,068	.....	.....	12,950	32,299
Greece	39,060	71,951	13,200	18,888	.....	.....	9,200	12,952
Newfoundland and Labrador	209,006	343,892	174,853	286,997	145,355	217,087	213,468	325,230
United Kingdom	11,388	52,591	1,436	19,725	10,229	20,587	10,431	24,726
Germany	3	58	2	76	1,729	5,602	1,323	6,223
Netherlands	.....	.....	223	420	5	72	.....	.....
Canada	95,005	251,086	50,480	106,038	106,675	201,882	179,860	409,098
Belgium	158	644	.....	.....	.....	.....	6	30
Russia in Europe	12,570	48,279	.....	.....	3,916	16,709	.....	.....
Sweden	259,911	1,391,976	219,238	1,215,588	333,863	1,781,579	356,074	1,901,988
Other countries	57,495	134,579	5,013	30,898	12,150	63,235	[a] 63,256	[a] 271,289
Total	2,591,031	7,832,225	1,811,732	5,412,636	2,104,576	6,499,690	2,594,770	8,336,819

[a] Of this, 57,225 tons, valued at $216,852, was from Venezuela and 4,40 tons, valued at $46,718, was from Egypt.

[1] Iron Trade Review, June 18, 1914, p. 1103.

The following table shows the imports of iron ore into the United States from 1910 to 1913, by ports of entry:

Quantity and value of iron ore imported into the United States in the calendar years 1910–1913, by customs districts, in long tons.

Customs district.	1910		1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Baltimore	1,137,916	$3,575,059	806,354	$2,305,042	840,488	$2,359,765	1,076,452	$3,186,388
Boston	235	853	100	272	98	252	.....	.....
New York	78,556	213,282	11,263	32,077	826	3,191	19,336	60,404
Philadelphia	1,269,180	3,775,770	984,192	3,039,994	1,229,737	4,072,776	1,393,096	4,809,961
Chicago	7,679	22,610	.....	.....	.....	.....	.....	.....
Puget Sound	25,000	47,750	.....	.....	.....	.....	.....	.....
San Francisco	.....	.....	10	250	.....	.....	50	168
Buffalo Creek	4,200	4,473	2,730	5,255	283	1,367	5,944	26,723
Champlain	29	73	146	1,904	30	660	620	2,540
Cuyahoga	.....	.....	2,902	6,675	3,113	5,448	75,556	184,401
Detroit	306	765	23	105	.....	.....	.....	.....
Erie	.....	.....	.....	.....	.....	.....	.....	.....
Miami	63,966	172,824	.....	.....	28,958	50,677	17,116	38,302
Niagara	2,343	11,166	1,668	8,343	810	3,818	2,137	11,332
Oswegatchie	25	75	50	150	.....	.....	.....	.....
Vermont	137	1,509	47	188	206	606	577	4,445
St. Louis	.....	.....	70	1,034	.....	.....	.....	.....
Genesee	10	553	13	527	27	1,130	3,501	9,981
Other districts	1,449	5,463	2,164	10,820	.....	.....	385	2,174
Total	2,591,031	7,832,225	1,811,732	5,412,636	2,104,576	6,499,690	2,594,770	8,336,819

In the following table is shown the importation of iron ore into the United States as far as has been recorded. Iron ore was imported from Europe in large quantities for the first time in 1879, most of the ore prior to that date coming from Canada:

Imports of iron ore into the United States, 1872–1913, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1872	23,733	1886	1,039,433	1901	966,950
1873	45,981	1887	1,194,301	1902	1,165,470
1874	57,987	1888	587,470	1903	980,440
1875	56,655	1889	853,573	1904	487,613
1876	17,284	1890	1,246,830	1905	845,651
1877	30,669	1891	912,864	1906	1,060,390
1878	28,212	1892	806,585	1907	1,229,168
1879 [a]	150,197	1893	526,951	1908	776,898
1879 [b]	284,141	1894	167,307	1909	1,694,957
1880	493,408	1895	524,153	1910	2,591,031
1881	782,887	1896	682,806	1911	1,811,732
1882	589,655	1897	489,970	1912	2,104,576
1883	490,875	1898	187,208	1913	2,594,770
1884	487,820	1899	674,082		
1885	390,786	1900	897,831	Total	33,031,300

[a] Fiscal years end. [b] Calendar years begin.

EXPORTS.

The quantity of iron ore exported from the United States in 1913 amounted to 1,042,151 long tons, valued at $3,513,419, or $3.37 per ton, as compared with 1,195,742 long tons, valued at $3,537,289, or $2.96 per ton, in 1912. This represents a decrease in quantity of 153,591 long tons, or 13 per cent, and in value of $23,870, or 0.7 per cent

In the following table is shown the exportation of iron ore from the United States, by customs districts, from 1910 to 1913. The data regarding exports are furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Quantity and value of iron ore exported from the United States in the calendar years 1910–1913, by customs districts, in long tons.

Customs district.	1910		1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
New York			10	$68			22	$206
Savannah	10	$75						
Norfolk and Portsmouth			37	357	2	$18		
Saluria			4,175	9,412				
Buffalo Creek	1,203	6,054	2,115	10,575			43,373	130,065
Champlain	19,941	71,740	13,583	49,278	19,200	76,359	36,778	147,331
Duluth	187,042	650,654	75,232	265,360	165,420	579,586	402,557	1,426,586
Niagara	2,848	12,956	369	1,550	94	330	83	678
Superior	519,396	1,683,824	657,895	2,286,908	991,437	2,841,677	525,348	1,740,573
Puget Sound	18,435	48,861	14,970	29,940	19,570	39,125	33,990	67,980
Baltimore					1	4		
North Dakota and South Dakota					18	190		
Total	748,875	2,474,164	768,386	2,653,448	1,195,742	3,537,289	1,042,151	3,513,419

The quantity of iron ore exported from the United States, so far as recorded, is shown in the following table:

Exports of iron ore from the United States, 1899–1913, in long tons.

Year.	Quantity.	Year.	Quantity.
1899	40,665	1908	309,099
1900	51,460	1909	455,934
1901	64,703	1910	748,875
1902	88,445	1911	768,386
1903	80,611	1912	1,195,742
1904	213,865	1913	1,042,151
1905	208,017		
1906	265,240	Total	5,811,801
1907	278,608		

IRON-ORE INDUSTRY OF CUBA.

The iron ore shipped from Cuba in 1913 amounted to 1,582,431 long tons, valued at $4,505,504, compared with 1,397,797 long tons, valued at $3,968,516, in 1912, an increase in quantity of 184,634 tons, or more than 13 per cent, and in value of $536,988, or 13.5 per cent. The shipments in 1913 exceeded the record shipments of 1910, which were 1,462,498 long tons. The 1913 shipments consisted of 69 per cent of hematite, including a little magnetite, and 31 per cent of brown ore. The iron content of the hematite, dried at 212° F., ranged from 56.65 per cent to 58.35 per cent; the magnetic hematite carried about 57 per cent and the brown ore about 55.5 per cent of iron. The total stock of ore reported as on hand at the close of 1913 was 564,772 long tons, compared with 696,068 long tons at the close of 1912. This included both natural and nodulized ore.

The following table shows the shipments of iron ore from Cuba since the opening of the mines in 1884. The statistics of the Cuban

iron-ore shipments are collected by the United States Geological Survey.

Shipments of iron ore from mines in the Province of Oriente (Santiago), Cuba, 1884–1913, in long tons.

Year.	Juragua Iron Co. (Ltd.) (hematite and magnetite).	Sigua Iron Co. (hematite).	Spanish-American Iron Co.		Cuban Steel Ore Co. (hematite).	Ponupo Manganese Co., El Cuero iron mines (hematite).	Total.
			Daiquiri mines (hematite).	Mayari mines (brown ore).			
1884	25,295						25,295
1885	80,716						80,716
1886	112,074						112,074
1887	94,240						94,240
1888	206,061						206,061
1889	260,291						260,291
1890	363,842						363,842
1891	264,262						264,262
1892	335,236	6,418					341,654
1893	337,155	14,020					351,175
1894	156,826						156,826
1895	307,503		74,991				382,494
1896	298,885		114,110				412,995
1897	[a] 248,256		[b] 206,029				454,285
1898	83,696		80,225				163,921
1899	161,783		211,442				373,225
1900	154,871		293,195				448,066
1901	199,764		[c] 334,974		17,651		552,389
1902	221,039		455,105		23,590		699,734
1903	155,898		467,629				623,527
1904	31,162		356,111				387,273
1905	139,828		421,331				561,159
1906	133,379		507,195				640,574
1907	181,063		469,111				650,174
1908	366,580		254,256				620,836
1909	356,659		519,752			59,721	936,132
1910	318,814		670,976	307,700		165,008	1,462,498
1911	355,132		252,717	387,791		168,074	1,163,714
1912	360,094		463,533	446,176		127,994	1,397,797
1913	369,213		591,322	491,713		130,183	1,582,431
Total	6,679,617	20,438	6,744,004	1,633,380	41,241	650,980	15,769,660

[a] Of this quantity, 5,932 tons were sent to Pictou, Nova Scotia.
[b] Of this quantity, 51,537 tons were sent to foreign ports.
[c] Of this quantity, 12,691 tons were sent to foreign ports.

PRODUCTION OF IRON ORE IN PRINCIPAL COUNTRIES.

The latest available statistics of production of iron ore in the principal producing countries since 1900 are given in the accompanying table.

Figures for all foreign countries, except Algeria, Belgium, Canada, Cuba, France, German Empire and Luxemburg, Italy, Spain, and Tunis, are taken from Mines and Quarries, London For the above-named countries, except Algeria, Cuba, and Tunis, the figures are taken from the official statistical reports published by the several Governments The figures for Algeria and Tunis are taken from the official statistical report of the French Government, the figures for Cuban shipments are collected by the United States Geological Survey, and the figures for the Philippine Islands are derived from the report of the Bureau of Mines, Manila, P. I.

In the original publication the statistics of many of the countries are given in metric tons, but these have for the sake of comparison been reduced to long tons.

Production of iron ore in principal countries, 1910–1913, in long tons.

Country.	1910	1911	1912	1913
North America:				
Canada[a]	231,623	187,807	192,753	274,673
Cuba[a]	1,462,498	1,163,714	1,397,797	1,582,431
Newfoundland	1,108,762	1,171,992	(b)	(b)
United States	57,014,906	43,876,552	55,150,147	61,980,437
South America:				
Chile	.....	28,150	(b)	(b)
Europe:				
Austria-Hungary	4,592,572	4,779,851	(b)	(b)
Belgium	121,024	148,130	164,734	(b)
France	14,375,984	16,376,967	(b)	(b)
German Empire and Luxemburg	28,257,579	29,408,812	(b)	(b)
Greece	527,040	493,106	(b)	(b)
Italy	542,578	367,900	572,900	(b)
Norway	100,834	217,051	(b)	(b)
Portugal	3,307	19,233	(b)	(b)
Russia	(c)	(c)	(b)	(b)
Spain	8,530,310	8,635,523	(b)	(b)
Sweden	5,465,234	6,056,868	(b)	(b)
United Kingdom	15,226,015	15,519,424	13,790,391	(b)
Asia:				
China[d]	130,472	109,542	(b)	(b)
India	54,626	366,180	(b)	(b)
Japan	(e)	(e)	(b)	(b)
Chosen (Korea)	104,627	96,902	(b)	(b)
Philippine Islands	148	216	347	(b)
Africa:				
Algeria	1,048,228	1,057,087	(b)	(b)
Madagascar	(f)	(f)	(b)	(b)
Natal	50	(b)	(b)	(b)
Tunis	327,756	397,638	(b)	(b)
Australia	157,821	122,361	(b)	(b)

[a] Shipments.
[b] Statistics not yet available.
[c] Russia produced 2,936,024 long tons of pig iron in 1910, and 3,536,417 tons in 1911.
[d] Exports.
[e] Japan produced 66,131 long tons of pig iron in 1910, and 52,223 tons in 1911.
[f] Nearly 8 tons of iron (metal) produced in 1910, and 1.5 tons in 1911.

IRON AND STEEL INDUSTRY OF THE UNITED STATES.[1]

PRODUCTION, SALES, AND VALUE OF PIG IRON, BY STATES.

According to the Bureau of Statistics of the American Iron and Steel Institute, which is continuing the statistical work of the former American Iron and Steel Association, the production of all kinds of pig iron, including such ferro-alloys as spiegeleisen, ferromanganese, ferrosilicon, and ferrophosphorus, in 1913 was 30,966,152 long tons, compared with 29,726,937 tons produced in 1912, an increase of 1,239,215 tons, or 4.17 per cent.

The following table gives the production of all kinds of pig iron, by States, in 1912 and 1913, according to their rank in each year:

[1] The statistics for all steel production and the pig iron statistics prior to 1912, except those of marketed production, were published in the annual reports of the American Iron and Steel Association; beginning with 1912, they are according to the Bureau of Statistics of the American Iron and Steel Institute.

Production of pig iron in 1912 and 1913, by States, in long tons.[a]

State.	1912			State.	1913		
	Rank.	Quantity.	Per cent-age.		Rank.	Quantity.	Per cent-age.
Pennsylvania	1	12,552,131	42.23	Pennsylvania	1	12,954,936	41.84
Ohio	2	6,802,493	22.88	Ohio	2	7,129,525	23.02
Illinois	3	2,887,359	9.71	Illinois	3	2,927,832	9.45
New York	4	1,939,231	6.52	New York	4	2,065,825	6.67
Alabama	5	1,862,681	6.27	Alabama	5	2,057,911	6.65
Indiana, Michigan	6	1,770,628	5.96	Indiana, Michigan	6	1,775,883	5.73
Missouri, Colorado, California	7	397,731	1.34	Wisconsin, Minnesota	7	367,326	1.19
Tennessee	8	338,238	1.14	Virginia	8	341,815	1.10
Wisconsin, Minnesota	9	303,370	1.02	Missouri, Colorado, California	9	324,263	1.05
West Virginia	10	274,360	.92	Maryland	10	289,959	.94
Virginia	11	256,167	.86	Tennessee	11	280,541	.91
Maryland	12	219,546	.74	West Virginia	12	234,516	.76
Kentucky	13	68,760	.23	New Jersey	13	121,795	.39
New Jersey	14	36,876	.12	Kentucky, Mississippi	14	81,215	.26
Connecticut, Massachusetts, Georgia	15	17,366	.06	Connecticut, Massachusetts	15	12,810	.04
Texas	16	.....	.....	Georgia, Texas	16	.....	.....
Total	.....	29,726,937	100.00	Total	.....	30,966,152	100.00

[a] Bureau of statistics of the American Iron and Steel Institute.

The United States Geological Survey accepts as official the statistics of production of pig iron and ferro-alloys heretofore collected by the American Iron and Steel Asscoiation and, beginning with the last half of 1912, by the American Iron and Steel Institute, but it has been found necessary for the Survey also to make a statistical canvass of the pig-iron manufacturing industry in order to obtain the value of the product, the data for which can be obtained in no other way. It should be explained here that the only common term in which the production of diversified mineral products may be expressed is that of value—at mine, quarry, or manufacturing plant—and in order that the mineral production of the United States may be summarized the value of each product must be obtained. It has been found more accurate and convenient to obtain the value of the pig iron corresponding to the tonnage sold or used rather than that corresponding to the actual production in a given year, and thus in collecting and publishing the statistics of quantity and value of marketed production of pig iron the Survey is not duplicating the labors of the American Iron and Steel Institute but, instead, is presenting additional data to the iron trade—data that are available only to the Survey.

According to reports made to the United States Geological Survey by the manufacturers the marketed production of pig iron in 1913 amounted to 30,388,935 long tons, valued f. o. b. at the furnaces at $458,342,345, as compared with 30,180,969 long tons, valued at $420,563,388, in 1912, an increase in quantity of 207,966 tons, or 0.69 per cent, and in value of $37,778,957, or 8.98 per cent. The average price per ton in 1913 was $15.08, and in 1912 it was $13.93, an advance

in 1913 of $1.15 a ton. These values represent the approximate price per ton f. o. b. at the furnaces; this approximate price eliminates freight costs, selling commissions, and other items, which are included in the market prices of certain grades of pig iron as published in the trade journals.

The marketed production of pig iron includes the metal produced from foreign as well as domestic ore. The quantity and value of pig iron derived from ore imported from Cuba, Sweden, Newfoundland, Spain, Nova Scotia, Canada, Venezuela, Africa, Greece, Brazil, and Russia (arranged in order of quantity), although it constitutes a very small percentage of the total production, is considerable, as the sales of this metal, derived from foreign ore, amounted in 1913 to 1,243,901 long tons, valued at $18,708,589, as compared with 1,199,774 long tons, valued at $18,184,935, in 1912. In the manufacture in 1913 of the 1,243,901 long tons of pig iron, 2,197,878 long tons of foreign iron ore was reported to have been used, thus indicating an average pig-iron yield of 56.60 per cent as compared with the tonnage of imported ore. The pig iron containing no foreign ore, made in 1913, represents 49.64 per cent of the tonnage of the available supply of domestic ore and zinc residuum.

The following table shows the quantity and value of pig iron, exclusive of ferro-alloys, marketed in the United States in 1912 and 1913, by States, together with the increase or decrease and percentage of increase or decrease in 1913:

Quantity and value of pig iron marketed in the United States in 1912 and 1913, by States, with increase or decrease and percentage of increase or decrease in 1913, in long tons.

State.	1912		1913		Increase (+) or decrease (−) in 1913.		Percentage of increase (+) or decrease(−)in1913.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	1,987,753	$21,371,053	1,924,762	$23,242,374	− 62,991	+$1,871,321	− 3.17	+ 8.76
Illinois	2,806,378	42,828,816	2,892,263	45,796,966	+ 85,885	+ 2,968,150	+ 3.06	+ 6.93
Kentucky	77,578	1,221,161	59,071	950,484	− 18,507	− 270,677	−23.86	−22.17
Michigan	459,975	6,579,048	447,188	6,568,920	− 12,787	− 10,128	− 2.78	− .15
New York	1,973,090	28,059,058	1,967,449	30,203,673	− 5,641	+ 2,144,615	− .29	+ 7.64
Ohio	7,127,176	93,140,369	6,913,961	103,824,517	−213,215	+10,684,148	− 2.99	+11.47
Pennsylvania	12,437,685	181,569,299	12,871,349	197,726,314	+433,664	+16,157,015	+ 3.49	+ 8.90
Tennessee	339,397	4,171,153	270,481	3,576,485	− 68,916	− 594,668	−20.31	−14.26
Virginia	328,961	4,364,708	380,508	5,310,167	+ 51,547	+ 945,459	+15.67	+21.66
Wisconsin	270,981	3,883,125	292,793	4,430,117	+ 21,812	+ 546,992	+ 8.05	+14.09
Other States [a]	2,371,995	33,375,598	2,369,110	36,712,328	− 2,885	+ 3,336,730	− .12	+10.00
Total	30,180,969	420,563,388	30,388,935	458,342,345	+207,966	+37,778,957	+ .69	+ 8.98

[a] California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia.

The following table gives the annual average price per long ton of pig iron in the United States for the years 1889 to 1913. The prices prior to 1907 include the cost of transportation from blast furnaces to markets. Prior to 1910 the values of ferro-alloys are included. The extreme range in prices, from $9.76 in 1894 to $20.92 in 1902, is of interest. The lowest prices occurred in the years 1894 to 1898, and the highest range was in the years 1902 to 1907.

Average price per long ton of pig iron in the United States, 1889–1913.

1889	$15.78	1898	$9.90	1907	$20.56
1890	16.43	1899	18.00	1908	15.96
1891	15.50	1900	18.85	1909	16.25
1892	14.32	1901	15.25	1910	15.45
1893	11.90	1902	20.92	1911	14.07
1894	9.76	1903	19.12	1912	13.93
1895	11.14	1904	14.13	1913	15.08
1896	10.47	1905	16.63		
1897	9.85	1906	19.98		

The average price of pig iron per long ton, by States, from 1910 to 1913, according to the manufacturers' reports to the Survey, is given in the following table. This represents the price at the blast furnaces and does not include the prices of ferro-alloys.

Average price per long ton of pig iron in the United States, 1910 to 1913, by States.

State.	1910	1911	1912	1913
Alabama	$12.25	$10.75	$10.75	$12.08
Illinois	15.91	15.30	15.26	15.83
Kentucky	16.07	15.01	15.74	16.09
Michigan	16.62	15.34	14.30	14.69
New Jersey	15.88	(a)	(b)	(a)
New York	16.72	15.56	14.22	15.35
Ohio	15.29	13.68	13.07	15.02
Pennsylvania	15.84	14.23	14.60	15.36
Tennessee	12.99	11.56	12.29	13.22
Virginia	13.85	12.62	13.27	13.96
Wisconsin	15.77	15.51	14.33	15.13
Other States [b]	15.63	14.94	14.07	15.50
Total	15.45	14.07	13.93	15.08

[a] Included in "Other States."

[b] 1910: California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1911: California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1912 and 1913: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia.

BLAST FURNACES.

The following notes on the blast-furnace situation in the United States at the close of 1913 are derived from a recent publication of the American Iron and Steel Institute:[1]

Furnaces in blast.—The whole number of furnaces in blast on December 31, 1913, was 205, against 304 on June 30, 1913, and 313 on December 31, 1912. The number of furnaces idle on December 31, 1913, including furnaces being rebuilt, was 257, against 158 on June 30, 1913, and 153 on December 31, 1912.

During the first six months of 1913 the total number of furnaces actually in blast during any part or the whole of the period was 348, and during the last half of the year the number was 330. During the first half of 1912 the number of furnaces actually in blast was 302, as compared with 337 in the second half.

Furnaces building and rebuilding.—On December 31, 1913, there were 3 furnaces in course of erection and 8 were rebuilding. Of the

[1] Bur. Statistics Am. Iron and Steel Inst., special statistical Bull. No. 1, Feb. 14, 1914.

building furnaces 1 was in Pennsylvania and 2 were in Minnesota. When completed all will use coke for fuel. They will have a total annual capacity of 505,000 long tons of pig iron.

New and revived furnaces.—In 1913 there were 5 entirely new blast furnaces built, 4 coke and 1 charcoal, with an annual capacity of 596,000 long tons, as follows: Pennsylvania, 2, with an annual capacity of 360,000 tons; Virginia, 1, with an annual capacity of 50,000 tons; Ohio, 1, with an annual capacity of 182,500 tons; and Mississippi, 1 (charcoal), with an annual capacity of 3,500 tons. In addition 1 charcoal furnace in Georgia, with an annual capacity of 13,500 tons, was revived.

Furnaces abandoned.—During 1913 there were 10 blast furnaces abandoned or dismantled, with a total annual capacity of 316,000 long tons, as follows: New York, 1, with an annual capacity of 30,000 tons; Pennsylvania, 4, with an annual capacity of 76,000 tons; Virginia, 2, with an annual capacity of 50,000 tons; Tennessee, 1, with an annual capacity of 48,000 tons; Ohio, 1, with an annual capacity of 85,000 tons; and Michigan, 1, with an annual capacity of 27,000 tons. When last in blast 2 furnaces, with an annual capacity of 29,000 tons, used charcoal, and 8 furnaces, with an annual capacity of 287,000 tons, used mineral fuel. Some of these furnaces had been idle for many years.

The following table shows the number of blast furnaces in blast on June 30 and December 31 and the total number of stacks recorded for the years 1912 and 1913, but does not, of course, include the electric reduction furnace at Heroult, Cal.:

Record of blast furnaces in the United States, 1911 and 1913, by States.[a]

State.	Furnaces in blast June 30, 1912.	Dec. 31, 1912.			Furnaces in blast June 30, 1913.	Dec. 31, 1913.		
		In.	Out.	Total.		In.	Out.	Total.
Pennsylvania	108	128	35	163	117	78	83	161
Ohio	49	58	17	75	62	40	35	75
Illinois	20	22	4	26	23	11	15	26
Alabama	19	25	24	49	23	23	26	49
New York	17	19	10	29	20	12	16	28
Virginia	6	7	18	25	9	8	16	24
Tennessee	9	7	12	19	8	4	14	18
Colorado	3	3	3	6	3	1	5	6
Missouri	1	1	1	2	1	1	1	2
Oregon	0	0	1	1	0	0	1	1
Washington	0	0	1	1	0	0	1	1
California	0	0	0	0	0	0	0	0
Maryland	2	3	2	5	3	1	4	5
New Jersey	1	1	6	7	2	2	5	7
Wisconsin	3	5	2	7	5	4	3	7
Minnesota	1	1	0	1	1	1	0	1
Indiana	10	10	0	10	10	5	5	10
Michigan	10	12	4	16	9	10	5	15
West Virginia	2	3	1	4	3	1	3	4
Kentucky	1	3	5	8	2	1	7	8
Georgia	0	0	3	3	0	0	4	4
Texas	0	0	4	4	0	0	4	4
Mississippi	0	0	0	0	0	0	1	1
Connecticut	3	3	0	3	2	1	2	3
Massachusetts	1	2	0	2	1	1	1	2
Total	266	313	153	466	304	205	257	462

[a] From the Bureau of Statistics of the American Iron and Steel Institute.

MONTHLY PRODUCTION OF PIG IRON.

The accompanying diagram (fig. 5) illustrates the course of the manufacture of pig iron by months during the last six years. The sudden decline in production of pig iron at the close of October, 1907, the low production during the first half of 1908, the slow recovery of activity in the last half of 1908, the hesitating conditions early in 1909, the steady and rapid increase in production during the last part of that year, the gradual, almost uninterrupted, decline throughout the year 1910, the moderate production during 1911, broken by alternating declines and recoveries, the rising production of 1912 and early 1913, the record production of more than 2,822,000 tons in May, 1913, the fairly high production until October, and the sharp decline in the last two months of that year are graphically indicated.

PRODUCTION OF PIG IRON BY GRADES.

The following table shows the production of the principal grades of pig iron, from 1909 to 1911, inclusive, according to the statistics of the American Iron and Steel Association, and for 1912 and 1913 according to the American Iron and Steel Institute:

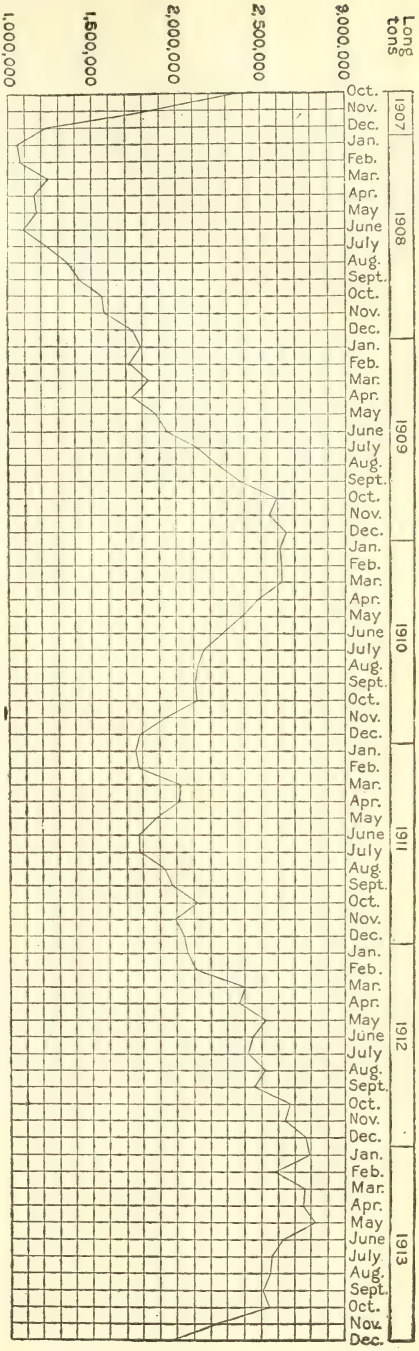
Long tons
1,000,000
1,500,000
2,000,000
2,500,000
3,000,000
1907
1908
1909
1910
1911
1912
1913
Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

FIGURE 5.—Curve showing production of coke and anthracite pig iron in the United States from October, 1907, to December, 1913, by months. Tonnage according to the Iron Age.

Production of pig iron in the United States, 1909–1913, by grades, in long tons.

Grade.	1909	1910	1911	1912	1913
Bessemer and low phosphorus	10,557,370	11,245,642	9,409,303	11,664,015	11,590,113
Basic (mineral fuel)	8,250,225	9,084,608	8,520,020	11,417,886	[a] 12,536,693
Forge pig iron	725,624	564,157	408,841	469,183	324,407
Foundry and ferrosilicon	5,322,415	5,260,447	4,468,940	5,073,873	5,220,343
Malleable	658,048	843,123	612,533	825,643	993,736
Spiegeleisen	142,831	153,055	110,236	96,346	110,338
Ferromanganese	82,209	71,376	74,482	125,378	119,495
White, mottled, direct castings, etc	56,749	81,159	45,192	54,613	71,027
Total	25,795,471	27,303,567	23,649,547	29,726,937	30,966,152

[a] Includes a small quantity of basic iron made with charcoal.

PRODUCTION OF PIG IRON ACCORDING TO FUEL USED.

In the following table are given the statistics of the American Iron and Steel Association showing the production of pig iron according to the fuel used, from 1909 to 1911, inclusive, and those of the American Iron and Steel Institute for 1912 and 1913. The charcoal figures include small quantities of pig iron made with charcoal and electricity. The totals for each of the five years also include small tonnages of ferro-alloys made with electricity, coke and electricity, etc.

Production of pig iron according to fuel used, 1909–1913, in long tons.

Fuel used.	1909	1910	1911	1912	1913
Bituminous, chiefly coke	24,721,037	26,257,978	23,141,296	29,132,733	30,326,130
Anthracite and coke	682,383	628,579	212,548	236,467	277,595
Anthracite alone	16,048	20,503	17,027	10,712	22,446
Charcoal	376,003	396,507	278,676	347,025	339,981
Total	25,795,471	27,303,567	23,649,547	29,726,937	30,966,152

TOTAL PRODUCTION OF PIG IRON.

The following table shows the production of pig iron, including the production of the commoner ferro-alloys, in the United States as far as has been recorded. The statistics for 1912 and 1913 are those of the American Iron and Steel Institute; those for years from 1854 to 1911 were collected by the American Iron and Steel Association; those for 1810, 1840, and 1850 are census figures; those for the other years are largely estimates by early statisticians.

Production of pig iron in the United States, 1810–1913, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1810	53,908	1865	831,770	1891	8,279,870
1820	20,000	1866	1,205,663	1892	9,157,000
1828	130,000	1867	1,305,023	1893	7,124,502
1829	142,000	1868	1,431,250	1894	6,657,388
1830	165,000	1869	1,711,287	1895	9,446,308
1831	191,000	1870	1,665,179	1896	8,623,127
1832	200,000	1871	1,706,793	1897	9,652,680
1840	286,903	1872	2,548,713	1898	11,773,934
1842	215,000	1873	2,560,963	1899	13,620,703
1846	765,000	1874	2,401,262	1900	13,789,242
1847	800,000	1875	2,023,733	1901	15,878,354
1848	800,000	1876	1,868,961	1902	17,821,307
1849	650,000	1877	2,066,594	1903	18,009,252
1850	563,755	1878	2,301,215	1904	16,497,033
1852	500,000	1879	2,741,853	1905	22,992,380
1854	657,337	1880	3,835,191	1906	25,307,191
1855	700,159	1881	4,144,254	1907	25,781,361
1856	788,515	1882	4,623,323	1908	15,936,018
1857	712,640	1883	4,595,510	1909	25,795,471
1858	629,548	1884	4,097,868	1910	27,303,567
1859	750,560	1885	4,044,526	1911	23,649,547
1860	821,223	1886	5,683,329	1912	29,726,937
1861	653,164	1887	6,417,148	1913	30,966,152
1862	703,270	1888	6,489,738		
1863	846,075	1889	7,603,642	Total	496,656,154
1864	1,014,282	1890	9,202,703		

MARKET PRICES OF PIG IRON.

In the following table are given the average monthly prices of the principal grades of pig iron either at the blast furnaces or at the nearest market, according to published market quotations:

Average monthly prices per ton of pig iron, 1912 and 1913, by months and kinds.

Month.	1912				1913			
	Foundry pig iron at Valley furnaces.[a]	Gray forge pig iron at Pittsburgh.[b]	Bessemer pig iron at Valley furnaces.[a]	Basic pig iron at Valley furnaces.[a]	Foundry pig iron at Valley furnaces.[a]	Gray forge pig iron at Pittsburgh.[b]	Bessemer pig iron at Valley furnaces.[a]	Basic pig iron at Valley furnaces.[a]
January	$13.00	$13.65	$14.08	$12.37	$17.50	$17.05	$17.25	$16.45
February	13.00	13.60	14.00	12.25	17.12	17.15	17.25	16.32
March	13.12	13.46	14.05	12.76	16.60	17.02	17.25	16.06
April	13.25	13.77	14.25	12.98	15.66	16.46	17.01	15.71
May	13.25	13.95	14.23	13.00	14.73	15.35	16.78	14.90
June	13.25	13.96	14.25	13.21	14.18	14.78	16.24	14.50
July	13.39	13.96	14.25	13.48	13.88	14.55	15.41	14.23
August	13.89	14.32	14.53	14.00	13.94	14.40	15.66	14.05
September	14.49	14.60	15.96	15.13	14.00	14.40	15.75	14.14
October	16.09	16.15	17.00	16.18	13.83	14.40	15.70	13.71
November	16.84	16.90	17.17	16.19	13.57	14.34	15.13	13.01
December	17.60	16.90	17.30	16.45	13.38	13.90	14.84	12.52

[a] Metal Statistics, New York, 1914. [b] Iron Trade Review.

The following table, compiled by the Iron Trade Review, summarizes the selling prices of Bessemer and Foundry No. 2 pig iron at the beginning of the buying season for the last 25 years:

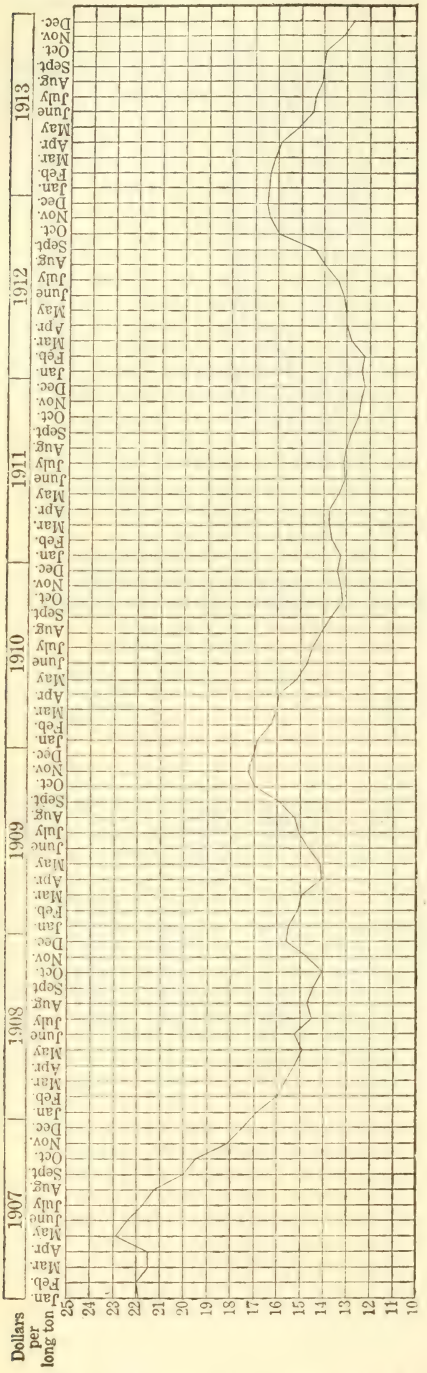

FIGURE 6.—Price curve of basic pig iron at Mahoning and Shenango Valley, Pa., furnaces, 1907 to 1913. Prices according to the Iron Age, Jan. 1, 1914.

Selling price of pig iron at date of buying movement.[a]

Season.	Date of buying movement.	Iron prices; Valley.	
		Bessemer.	Foundry iron No. 2.
1890....	Dec. 15, 1889	$22.15	$18.15
1891....	June 1, 1891	15.15	15.60
1892....	Jan. 31, 1892	15.00	13.65
1893....	Mar. 15, 1893	12.65	12.15
1894....	Mar. 1, 1894	9.65	9.60
1895....	Apr. 1, 1895	9.40	9.45
1896....	May 1, 1896	12.40	11.15
1897....	May 20, 1897	8.35	8.40
1898....	Mar. 20, 1898	9.55	9.80
1899....	Feb. 1, 1899	10.30	9.75
1900....	Dec. 15, 1899	24.15	22.15
1901....	Apr. 15, 1901	16.15	14.40
1902....	Feb. 1, 1902	15.90	15.90
1903....	Mar. 20, 1903	21.50	21.65
1904....	Apr. 15, 1904	13.35	13.15
1905....	Feb. 1, 1905	15.50	16.00
1906....	Dec. 5, 1905	17.25	17.25
1907....	Nov. 5, 1906	21.50	21.50
1908....	June 15, 1908	16.00	15.00
1909....	May 10, 1909	14.75	14.25
1910....	Dec. 24, 1909	19.00	17.25
1911....	Apr. 21, 1911	15.00	13.75
1912....	Mar. 20, 1912	14.25	13.25
1913....	Nov. 19, 1912	17.25	17.50
1914....	May 1, 1914	14.00	13.25

[a] Iron Trade Review.

FOREIGN TRADE IN PIG IRON.

IMPORTS.

The quantity of pig iron and ferro-alloys, the principal of which were ferromanganese, spiegeleisen, and ferrosilicon, imported into the United States in 1913 was 156,450 long tons, compared with 129,325 long tons imported in 1912, an increase of 27,125 tons, or nearly 21 per cent. The United Kingdom furnished the largest quantity in both years, with Germany, Canada, and China following in order of importance.

The statistics of imports of iron are furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce, and the following table gives the imports from the various countries from 1909 to 1913:

Pig iron and ferro-alloys imported for consumption into the United States in the calendar years 1909–1913, by countries, in long tons.

Country.	1909	1910	1911	1912	1913
Austria-Hungary	1,973	6,069	590	400	340
Germany	3,185	7,417	4,286	5,924	8,358
Netherlands	7,137	15,737	9,719	492	460
United Kingdom—England	151,563	182,082	114,947	110,526	131,340
United Kingdom—Scotland					1,581
Canada	2,844	3,175	4,260	4,998	4,609
China	4,836	13,924	11,857	1,750	3,017
Belgium					256
France					179
Norway					117
Sweden					2,002
Switzerland					1,680
Cuba					72
British India					2,439
Other countries	4,904	8,829	2,800	5,235	
Total	176,442	237,233	148,459	129,325	156,450

EXPORTS.

The quantity of pig iron and ferro-alloys exported from the United States in 1913 was 277,648 long tons, compared with 272,676 long tons in 1912, an increase of 4,972 tons, or 1.8 per cent. The largest quantity was shipped to Canada, and important quantities were shipped also to Italy, England, Australia and Tasmania, Austria-Hungary, Belgium, and Panama. The iron trade with South American countries is very small.

The following table shows the exports of pig iron and ferro-alloys from the United States to the various foreign countries by calendar years from 1909 to 1913, according to the Bureau of Foreign and Domestic Commerce, Department of Commerce:

Pig iron and ferro-alloys exported from the United States to foreign countries, 1909–1913, in long tons.

Country.	1909	1910	1911	1912	1913
Canada	44,758	115,642	98,293	208,581	193,396
Austria-Hungary	2,000	1,050		14,806	4,601
Italy	3,130	3,027	7,710	11,954	24,551
United Kingdom—England	5,980	3,994	8,526	25,617	20,972
United Kingdom—Scotland					396
United Kingdom—Ireland					26
Germany		336	293	2,403	1,723
Belgium	10	189	622	1,698	4,715
France		48	202	827	752
Denmark			125	168	48
Mexico	406	719	444	804	85
Panama	4,907	400	1,079	1,606	3,921
Cuba	178	733	1,122	734	646
Brazil	75			50	1,305
Chile		100	600	1,964	690
Peru	310	550	875	835	172
Philippines	100	407		259	54
Netherlands					1,516
Portugal					25
Costa Rica					310
Honduras					5
San Domingo					40
Argentine					792
Colombia					13
Uruguay					112
Venezuela					50
Japan					2,293
Australia and Tasmania					14,354
New Zealand					85
Other countries	135	190	908	370	
Total	61,989	127,385	120,799	272,676	277,648

PRODUCTION OF PIG IRON IN PRINCIPAL COUNTRIES.

The following table is taken from "Metal Statistics."[1] The grand totals are regarded as representing the world's production of pig iron, and the fact that the United States produces about 40 per cent of the total and yet exports relatively so little is of interest.

Production of pig iron in principal countries in 1850, 1890, 1900, and 1910–1912, in long tons.

Country.	1850	1890	1900	1910	1911	1912
United States	563,755	9,202,703	13,789,242	27,303,567	23,649,547	29,726,937
Germany	350,000	4,584,882	8,381,373	14,559,509	15,404,648	17,586,521
Great Britain	2,300,000	7,904,214	8,959,691	10,012,098	9,718,638	8,839,124
France	405,653	1,931,188	2,669,966	3,974,478	4,309,498	4,870,913
Russia	227,555	912,561	2,889,789	2,992,058	3,531,807	4,133,000
Austria-Hungary	250,000	910,685	1,472,695	2,153,788	2,056,839	2,276,141
Belgium	144,452	775,385	1,001,872	1,822,821	2,072,836	2,307,853
Canada	.....	19,439	86,090	740,210	824,368	912,878
Sweden	150,000	483,155	518,203	594,385	621,367	688,757
Spain	.....	176,598	289,315	367,423	402,209	[a] 400,000
Italy	.....	14,094	23,569	347,647	298,144	373,960
Japan	.....	.....	.....	186,794	[a] 200,000	[a] 200,000
Other countries	10,000	80,000	100,000	[a] 250,000	[a] 200,000	[a] 200,000
Total	4,401,415	23,994,904	40,181,865	65,304,788	63,342,901	72,566,084

[a] Estimated. Estimate for 1913, 76,000,000 long tons.

FERRO-ALLOYS.[2]

MARKETED PRODUCTION.

The United States Geological Survey undertook for the first time in the iron report for 1911 to present the statistics of production of ferro-alloys separately from those of pig iron, with which they had been previously included. Although the quantity of ferro-alloys reported is small, amounting to only about 0.97 per cent of the total marketed production of pig iron during 1913, the value per ton is so much greater as to have an important influence on the apparent value of the pig iron if included with it, making it $15.36 a ton instead of $15.08; therefore it has been decided to separate the two products. There is a sufficient number of producers of the commoner ferro-alloys, such as ferromanganese and spiegeleisen, ferrosilicon, and ferrophosphorus, to give the production of these two groups of alloys separately; but the production of the rarer alloys, such as ferromolybdenum, ferrotitanium, ferrotungsten, and ferrovanadium, must be grouped together. It should also be stated that the values of the first two groups of ferro-alloys were in part estimated by the Survey for 1911 and almost entirely so for 1912 and 1913.

The total marketed production of ferro-alloys in 1913 as reported to the United States Geological Survey was 296,207 long tons, valued at $13,015,362, as compared with 328,685 long tons, valued at $12,223,776 in 1912. Of the production in 1913, 121,517 long tons, valued at $8,361,684, were made from imported ores derived from Australia,

[1] Metal Statistics 1914, p. 35: The American Metal Market Co., New York.

[2] Notes on manganese ferro-alloys are given in the chapter on the production of manganese and manganiferous ores in Mineral Resources for 1913.

Brazil, Canada, India, Indo-China, and Russia. The ferrovanadium, ferromolybdenum, ferromanganese, ferrotitanium, and ferrotungsten were made wholly or in part from imported ore. The quantity reported does not represent the total production of the United States, as the sales of considerable quantities of electrically produced ferro-alloys were not reported to the Survey.

The sales of ferromanganese and spiegeleisen in 1913 amounted to 226,475 long tons, valued at $9,272,269, compared with 227,939 long tons, valued at $8,282,006, marketed in 1912. The sales of ferrosilicon and ferrophosphorus in 1913 amounted to 67,164 long tons, valued at $1,233,465, compared with 97,371 long tons, valued at $1,795,707, in 1912. The sales of alloys of iron with the rarer metals, molybdenum, titanium, tungsten, and vanadium, amounted in 1913 to 2,568 long tons, valued at $2,509,628, compared with 3,375 long tons, valued at $2,146,063, in 1912, thus showing a decrease in quantity of 807 long tons, but an increase in value of $363,565. These alloys were therefore valued at an average price of more than $977 a ton in 1913, compared with $636 a ton in 1912. Of this total, ferrotitanium predominated in quantity but ferrovanadium in value.

The following table gives a partial outline of the ferro-alloy sales. in the United States in 1911, 1912, and 1913:

Marketed production of ferro-alloys in 1911, 1912, and 1913, in long tons.

Kind of alloy.	1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Ferromanganese and spiegeleisen	178,615	$4,746,541	227,939	$8,282,006	226,475	$9,272,269
Ferrosilicon and ferrophosphorus	70,122	1,345,884	97,371	1,795,707	67,164	1,233,465
Ferromolybdenum, Ferrotitanium (10 to 20 per cent titanium), Ferrovanadium, Ferrotungsten (above 50 per cent tungsten), Other	4,638	2,285,407	3,375	2,146,063	2,568	2,509,628
Total	253,375	8,377,832	328,685	12,223,776	296,207	13,015,362

IMPORTS.

According to the Bureau of Foreign and Domestic Commerce, the imports for consumption of ferromanganese into the United States in 1913 were 128,070 long tons, valued at $5,682,915, as compared with 99,137 long tons, valued at $3,906,920, in 1912, and those of spiegeleisen in 1913 were 77 long tons, valued at $2,173, as compared with 1,015 long tons, valued at $28,094, in 1912. The imports of the alloys of the rarer metals are not all reported separately. For instance, the imports of ferrochrome are combined with those of chromium; those of ferromolybdenum are combined with those of the metal molybdenum; and those of ferrotungsten are included with those of tungsten. For the sake of comparison, however, such statistics as are available are presented in the following table:

Imports of ferro-alloys in 1911, 1912, and 1913, in long tons.

Ferro-alloy.	Value per ton.	1911		1912		1913	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Chrome or chromium and ferrochrome.	$200 or less	240.03	$20,173	436	$47,179	(a)	(a)
	More than $200	13.50	7,729	38	30,408	(a)	(a)
Total		253.53	27,902	474	77,587	307	$51,415
Ferrophosphorus	$200 or less	186.13	8,520	103	4,465		
Ferrosilicon	15 per cent or less silicon.						
	More than 15 per cent silicon.	6,658.00	341,681	7,490	446,456	7,208	449,871
Ferrovanadium	More than $200	1.07	2,623				
Molybdenum and ferromolybdenum.	do	8.50	11,409	4	4,670	7	15,939
Titanium and ferrotitanium.	$200 or less	.69	97	7	306		
	More than $200	45.00	22,403	16	7,325	15	7,198
Total		45.69	22,500	23	7,631	15	7,198
Tungsten and ferrotungsten.	More than $200	115.07	143,802	288	323,872	661	835,212
Ferromanganese		80,263	3,015,062	99,137	3,906,920	128,070	5,682,915
Spiegeleisen		20,970	405,444	1,015	28,094	77	2,173
Total		108,500.99	3,978,943	108,534	4,799,695	136,345	7,044,723

(a) Not separately stated.

PRODUCTION OF STEEL BY STATES AND KINDS.

The tables that follow show the production of the various steels, according to the American Iron and Steel Association prior to 1912 and according to the Bureau of Statistics of the American Iron and Steel Institute for 1912 and 1913.

The production of Bessemer steel ingots and castings in the leading States from 1909 to 1913 was as follows:

Production of Bessemer steel ingots and castings, 1909–1913, by States, in long tons.

State.	1909	1910	1911	1912	1913
Ohio	3,466,077	3,314,053	3,268,994	4,285,673	4,024,662
Pennsylvania	2,845,602	2,975,750	2,338,813	3,157,928	2,954,818
Illinois	1,632,444	1,693,053	1,335,053	1,559,576	1,475,274
Other States	1,386,660	1,429,916	1,004,994	1,324,724	1,090,952
Total	9,330,783	9,412,772	7,947,854	10,327,901	9,545,706

The following table gives the production of open-hearth steel ingots and castings in the leading States from 1909 to 1913:

Production of open-hearth steel ingots and castings, 1909–1913, by States, in long tons.

State.	1909	1910	1911	1912	1913
New England States	257,392	223,158	189,879	214,325	195,419
New York and New Jersey	618,117	713,245	679,152	792,201	996,312
Pennsylvania	9,400,287	10,153,816	9,594,914	12,408,109	12,532,227
Ohio	1,424,452	1,733,409	1,721,549	2,565,343	2,726,219
Indiana	783,957	1,307,129	1,394,520	2,001,937	2,180,106
Illinois	1,052,572	995,011	801,624	1,235,166	1,264,854
Other States	957,159	1,378,741	1,217,012	1,563,642	1,714,794
Total	14,493,936	16,504,509	15,598,650	20,780,723	21,599,931

The following table gives the production, by States, of basic and acid open-hearth steel ingots and castings in 1912 and 1913:

Production of basic and acid open-hearth steel ingots and castings in 1912 and 1913, by States, in long tons.

State.	1912			1913		
	Basic open-hearth steel.	Acid open-hearth steel.	Total.	Basic open-hearth steel.	Acid open-hearth steel.	Total.
New England States	158,482	55,843	214,325	136,754	58,665	195,419
New York and New Jersey	712,998	79,203	792,201	919,506	76,806	996,312
Pennsylvania	11,556,362	851,747	12,408,109	11,578,352	943,875	12,522,227
Ohio	2,521,086	44,257	2,565,343	2,680,357	45,862	2,726,219
Indiana	1,965,003	36,934	2,001,937	2,116,261	63,845	2,180,106
Illinois	1,217,775	17,391	1,235,166	1,251,285	13,569	1,264,854
Other States	1,509,796	53,846	1,563,642	1,662,111	52,683	1,714,794
Total	19,641,502	1,139,221	20,780,723	20,344,626	1,255,305	21,599,931

The following table gives the production by States and by processes of all kinds of steel ingots and castings in 1912 and 1913:

Production of all kinds of steel ingots and castings in 1912 and 1913, by States, in long tons.

State.	1912				1913			
	Bessemer.	Open-hearth.	Crucible and all other.	Total ingots and castings.	Bessemer.	Open-hearth.	Crucible and all other.	Total ingots and castings.
Massachusetts, Rhode Island, and Connecticut	1,766	214,325	4,218	220,309	2,476	195,419	2,716	200,611
New York and New Jersey	514,657	792,201	42,628	1,349,486	371,372	996,312	39,032	1,406,716
Pennsylvania	3,157,928	12,408,109	67,717	15,633,754	2,954,818	12,522,227	77,249	15,554,294
Delaware, Maryland, District of Columbia, Virginia, West Virginia, Kentucky, Tennessee, Georgia, Alabama, Louisiana, and Texas	695,846	1,011,636	1,150	1,708,632	637,063	1,183,977	1,285	1,822,325
Ohio	4,285,673	2,565,343	5,013	6,856,029	4,024,662	2,726,219	4,170	6,755,051
Indiana and Illinois	1,559,576	3,237,103	12,009	4,808,688	1,475,424	3,444,960	20,600	4,940,984
Other States[a]	112,455	552,006	9,944	674,405	79,891	530,817	10,185	620,893
Total	10,327,901	20,780,723	142,679	31,251,303	9,545,706	21,599,931	155,237	31,300,874

[a] Figures for 1912 and 1913 include Canal Zone.

PRODUCTION OF ELECTRIC STEEL.[1]

The production of steel by the electric process in 1913 amounted to 30,180 tons, as compared with 18,309 tons in 1912, an increase of 11,871 tons, or over 64.8 per cent. The following table gives the production of electric steel ingots and castings since 1909. In 1908 there were 55 tons of electric steel produced, but this tonnage was included with open-hearth steel for that year.

[1] American Iron and Steel Inst. Bur. Statistics Special Statistical Bulletin No. 5, 1914.

Production of electrically manufactured steel in the United States, 1909 to 1913, in long tons.

Years.	Ingots.	Castings.	Total.
1909	13,456	306	13,762
1910	50,821	1,320	52,141
1911	27,227	1,878	29,105
1912	14,147	4,162	18,309
1913	20,973	9,207	30,180

In the total production of electric steel in 1913 are included about 11,254 tons of steel ingots and castings which were treated with ferrovanadium, ferrotitanium, ferrochrome, etc., of which about 10,821 tons were ingots and about 433 tons were castings. In 1912 the production of similarly treated steel amounted to about 9,609 tons—about 9,217 tons of ingots and about 392 tons of castings.

On December 31, 1913, the number of completed plants which were equipped for the manufacture of steel by the electric process was 19, as compared with 14 plants at the close of 1912, a gain of 5 plants. In addition 3 plants were being built on December 31, 1913—1 in New York, 1 in Pennsylvania, and 1 in Oregon—and 7 plants were projected—1 in New York, 1 in New Jersey, 2 in Pennsylvania, 1 in Tennessee, 1 in Ohio, and 1 in Michigan.

PRODUCTION OF STEEL BY MISCELLANEOUS PROCESSES.

The production of steel in 1913 by various minor processes amounted to 3,831 tons, against 2,853 tons in 1912. Of the production in 1913 about 587 tons were ingots and about 3,244 tons were direct castings. Included in the total are about 10 tons of nickel steel castings. In 1913, 5 plants made steel by the cementation and other minor processes, as follows: Connecticut, 1; Pennsylvania, 1; Ohio, 1; and Indiana, 2. In 1912, 4 plants were active. The following table gives the production of miscellaneous steel ingots and castings since 1898:

Production of miscellaneous steel ingots and castings in the United States, 1898 to 1913, in long tons.

Year.	Ingots.	Castings.	Total.	Year.	Ingots.	Castings.	Total.
1898	225	3,576	3,801	1906	3,510	10,870	14,380
1899	1,030	3,944	4,974	1907	989	13,086	14,075
1900	6	4,856	4,862	1908	519	5,613	6,132
1901	214	5,257	5,471	1909	786	8,390	9,185
1902	2,833	5,553	8,386	1910	.....	3,194	3,194
1903	3,395	6,409	9,804	1911	417	2,427	2,844
1904	2,172	7,018	9,190	1912	542	2,311	2,853
1905	2,572	6,391	8,963	1913	587	3,244	3,831

TOTAL PRODUCTION OF STEEL.

The statistics of the production of the various kinds of steel, so far as has been recorded, are given in the following table:

Production of steel in the United States, 1810–1913, in long tons.

Year.	Bessemer.	Open-hearth.	Crucible.	Other steel.	Total.
1810	.....	.....	917		917
1860	.....	.....	11,838		11,838
1863	.....	.....	8,075		8,075
1864	.....	.....	9,258		9,258
1865	.....	.....	13,627		13,627
1866	.....	.....	16,940		16,940
1867	2,679	.....	16,964		19,643
1868	7,589	.....	19,197		26,786
1869	10,714	893	19,643		31,250
1870	37,500	1,339	29,911		68,750
1871	40,179	1,785	31,250		73,214
1872	107,239	2,679	26,125	6,911	142,954
1873	152,368	3,125	31,059	12,244	198,796
1874	171,369	6,250	32,436	5,672	215,727
1875	335,283	8,080	35,180	11,256	389,799
1876	469,639	19,187	35,163	9,202	533,191
1877	500,524	22,349	36,098	10,647	569,618
1878	653,773	32,255	38,309	7,640	731,977
1879	829,439	50,259	50,696	4,879	935,273
1880	1,074,262	100,851	64,664	7,558	1,247,335
1881	1,374,247	131,202	80,145	2,720	1,588,314
1882	1,514,687	143,341	75,973	2,691	1,736,692
1883	1,477,345	119,356	71,835	4,999	1,673,535
1884	1,375,531	117,515	53,270	4,563	1,550,879
1885	1,519,430	133,376	57,599	1,515	1,711,920
1886	2,269,190	218,973	71,973	2,367	2,562,503
1887	2,936,033	322,069	75,375	5,594	3,339,071
1888	2,511,161	314,318	70,279	3,682	2,899,440
1889	2,930,204	374,543	75,865	5,120	3,385,732
1890	3,688,871	513,232	71,175	3,793	4,277,071
1891	3,247,417	579,753	72,586	4,484	3,904,240
1892	4,168,435	669,889	84,709	4,548	4,927,581
1893	3,215,686	737,890	63,613	2,806	4,019,995
1894	3,571,313	784,936	51,702	4,081	4,412,032
1895	4,909,128	1,137,182	67,666	858	6,114,834
1896	3,919,906	1,298,700	60,689	2,394	5,281,689
1897	5,475,315	1,608,671	69,959	3,012	7,156,957
1898	6,609,017	2,230,292	89,747	3,801	8,932,857
1899	7,586,354	2,947,316	101,213	4,974	10,639,857
1900	6,684,770	3,398,135	100,562	4,862	10,188,329
1901	8,713,302	4,656,309	98,513	5,471	13,473,595
1902	9,138,363	5,687,729	112,772	8,386	14,947,250
1903	8,592,829	5,829,911	102,434	9,804	14,534,978
1904	7,859,140	5,908,166	83,391	9,190	13,859,887
1905	10,941,375	8,971,376	102,233	8,963	20,023,947
1906	12,275,830	10,980,413	127,513	14,380	23,398,136
1907	11,667,549	11,549,736	131,234	14,075	23,362,594
1908	6,116,755	7,836,729	63,631	6,132	14,023,247
1909	9,330,783	14,493,936	107,355	22,947	23,955,021
1910	9,412,772	16,504,509	122,303	55,335	26,094,919
1911	7,947,854	15,598,650	97,653	31,949	23,676,106
1912	10,327,901	20,780,723	121,517	21,162	31,251,303
1913	9,545,706	21,599,931	121,226	34,011	31,300,874

BIBLIOGRAPHY.

SURVEY PUBLICATIONS ON IRON ORES.

A number of the principal papers on iron ores published by the United States Geological Survey are listed below. The publications here named, except those to which a price is affixed, may be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications, except the folios, may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. The folios are for sale by the Director of the United States Geological Survey. The publications marked "Exhausted" are no longer available for distribution, but may be consulted at the libraries of the larger cities and educational institutions. Several geologic folios, not specified in this list but given by number, contain descriptions of iron-ore deposits of more or less importance.

EASTERN AND SOUTHERN IRON ORES.

AGTHE, F. T., and DYNAN, J. L., Paint-ore deposits near Lehigh Gap, Pa.: Bull. 430, pp. 440–454, 1910.

BAYLEY, W. S., and others, Geol. Atlas, Passaic folio (No. 157), 1908. 25c.

BURCHARD, E. F., The iron ores of the Brookwood district, Alabama: Bull. 260, pp. 321–334, 1905. Exhausted.

——— The Clinton or red ores of the Birmingham district, Alabama: Bull 315, pp. 130–151, 1907.

——— The brown iron ores of the Russellville district, Alabama: Bull. 315, pp. 152–160, 1907.

——— Southern red hematite as an ingredient of metallic paint: Bull. 315, pp. 430–434, 1907. 50c.

——— An estimate of the tonnage of available Clinton iron ore in the Birmingham district, Alabama: Bull. 340, pp. 308–317, 1908.

——— Preliminary report on the red iron ores of east Tennessee, northeast Alabama, and northwest Georgia: Bull. 540, pp. 279–328, 1914.

——— Tonnage estimates of Clinton iron ore in the Chattanooga district of Tennessee, Georgia, and Alabama: Bull. 380, pp. 169–187, 1909. 40c.

——— BUTTS, CHARLES, and ECKEL, E. C., Iron ores, fuels, and fluxes of the Birmingham district, Alabama: Bull. 400, 1909.

BUTTS, CHARLES, Economic geology of the Kittanning and Rural Valley quadrangles, Pennsylvania: Bull. 279, pp. 171–174, 1906. 50c.

——— Iron ores in the Montevallo-Columbiana region, Alabama: Bull. 470, 18 pp. 1911.

ECKEL, E. C., Limonite deposits of eastern New York and western New England: Bull. 260, pp. 335–342, 1905. Exhausted.

——— The Clinton or red ores of northern Alabama: Bull. 285, pp. 172–179, 1906. Exhausted.

——— The Oriskany and Clinton iron ores of Virginia: Bull 285, pp. 183–189, 1906. Exhausted.

——— The mineral-paint ores of Lehigh Gap, Pennsylvania: Bull. 315, pp. 435–437, 1907. 50c.

——— Metallic paints of the Lehigh Gap district, Pennsylvania: Mineral Resources for 1906, pp. 1120–1122, 1907. Exhausted.

HARDER, E. C., The iron ores of the Appalachian region in Virginia: Bull. 380, pp. 215–254, 1909. 40c.

HAYES, C. W., and ECKEL, E. C., Iron ores of the Cartersville district, Georgia: Bull. 213, pp. 233–242, 1903. 25c.

HOLDEN, R. J., The brown ores of the New River-Cripple Creek district, Virginia: Bull. 285, pp. 190–193, 1906. Exhausted.

KEITH, A., Iron-ore deposits of the Cranberry district, North Carolina-Tennessee: Bull. 213, pp. 243–246, 1903. 25c.

KEMP, J. F., The titaniferous iron ores of the Adirondacks (New York): Nineteenth Ann. Rept., pt. 3, pp. 277–422, 1899. $2.00.

KINDLE, E. M., The iron ores of Bath County, Ky.: Bull. 285, pp. 180-182, 1906. Exhausted.
PHALEN, W. C., Iron ores near Ellijay, Ga.: Bull. 340-e, pp. 330–334, 1908.
SMITH, P. S., The gray iron ores of Talladega County, Ala.: Bull. 315, pp. 161–184, 1907.
SPENCER, A. C., The Jauss iron mine, Dillsburg, Pa.: Bull. 430, pp. 247–249, 1910.
——— and others, Geol. Atlas, Franklin Furnace folio (No. 161), 1908. 25c.
——— Magnetite deposits in Berks and Lebanon counties, Pa.: Bull. 315, pp. 185–189, 1907.
——— Magnetite deposits of the Cornwall type in Pennsylvania: Bull. 359, 1908.
WOLFF, J. E., Zinc and manganese deposits of Franklin Furnace, N. J.: Bull. 213, pp. 214–217, 1903. 25c.

LAKE SUPERIOR IRON ORES.

BAYLEY, W. S., The Menominee iron-bearing district of Michigan: Mon. 46, 1904. $1.75.
CLEMENTS, J. M., The vermilion iron-bearing district of Minnesota: Mon. 45, 1903. $3.50
——— SMYTH, H. L., BAYLEY, W. S., and VAN HISE, C. R., The Crystal Falls iron-bearing district of Michigan: Nineteenth Ann. Rept., pt. 3, pp. 1–157, 1898. $2.25. Also Mon. 36, 512 pp., 1899. $2.
IRVING, R. D., and VAN HISE, C. R., The Penokee iron-bearing series of Michigan and Wisconsin: Tenth Ann. Rept., pt. 1, pp. 341–507, 1889. $2.35,
——— The Penokee iron-bearing series of Michigan and Wisconsin: Mon. 19, 534 pp., 1892. $1.70
LEITH, C. K., The Mesabi iron-bearing district of Minnesota: Mon. 43, 316 pp., 1908. $1.50.
——— Geologic work in the Lake Superior iron district during 1902: Bull. 213, pp. 247–250, 1903. 25c.
——— The Lake Superior mining region during 1903: Bull. 225, pp. 215–220, 1904. Exhausted.
THWAITES, F. T., recent discoveries of "Clinton" iron ore in eastern Wisconsin: Bull. 540, pp. 338–342, 1914.
VAN HISE, C. R., The iron-ore deposits of the Lake Superior region: Twenty-first Ann. Rept., pt. 3, pp. 305–434, 1901. $1.75.
——— and BAYLEY, W. S., Geol. Atlas, Menominee special folio (No. 62), 1900. 25c.
——— and LEITH, C. K., The geology of the Lake Superior region: Mon. 52, 626 pp., 1911. $2.50.
——— BAYLEY, W. S., and SMYTH, H. L., Preliminary report on the Marquette iron-bearing district of Michigan: Fifteenth Ann. Rept., pp. 477–650, 1894. $1.70.
——— The Marquette iron-bearing district of Michigan, with atlas: Mon. 28, 608 pp., 1897. $5.75.

MISSISSIPPI BASIN AND GULF OF MEXICO IRON ORES.

ECKEL, E. C., Iron ores of northeastern Texas: Bull. 260, pp. 348–353, 1905. Exhausted.
KINDLE, E. M., The iron ores of Bath County, Ky.: Bull. 285, pp. 180–182, 1906. Exhausted.
PAIGE, SIDNEY. Preliminary report on pre-Cambrian geology and iron ores of Llano County, Tex.: Bull. 430, pp. 256–268, 1910.
——— Mineral resources of the Llano-Burnet region, Texas: Bull. 450, pp. 26–70, 1911.
PHALEN, W. C., Economic geology of the Kenova quadrangle (Kentucky, Ohio, and West Virginia): Bull. 349, 158 pp. 1908.

WESTERN IRON ORES.

BALL, S. H., The Hartville iron-ore range, Wyoming: Bull. 315, pp. 190–205, 1907.
——— Titaniferous iron-ore of Iron Mountain, Wyoming: Bull. 315, pp. 206–212, 1907.
BANCROFT, HOWLAND, Reconnaissance of the ore deposits in northern Yuma County, Ariz.: Bull. 451, 130 pp., 1911.
BOUTWELL, J. M., Iron ores in the Uinta Mountains, Utah: Bull. 225, pp. 221–228, 1904. Exhausted.

DILLER, J. S., Iron ores of the Redding quadrangle, California: Bull. 213, pp. 219–220, 1903. 25c.
——— So-called iron ore near Portland, Oreg.: Bull. 260, pp. 343–347, 1905. Exhausted.
HARDER, E. C., The Taylor Peak and Whitepine iron-ore deposits, Colorado: Bull. 380, pp. 188–198, 1909. 40c.
——— Some iron ores of western and central California: Bull. 430, pp. 219–227, 1910.
——— Iron ores near Dayton, Nev.: Bull. 430, pp. 240–246, 1910.
——— Deposits of brown iron ore near Dillsburg, York County, Pa.: Bull. 430, pp. 250–255, 1910.
——— Iron-ore deposits of the Eagle Mountains, California: Bull. 503, 81 pp., 1912.
——— and RICH, J. L., The Iron Age iron-ore deposit near Dale, San Bernardino County, Cal.: Bull. 430, pp. 228–239, 1910.
HILL, J. M., Mining districts of the western United States: Bull. 507, 309 pp., 1912.
LEITH, C. K., Iron ores in southern Utah: Bull. 225, pp. 229–237, 1904. Exhausted.
——— Iron ores of the western United States and British Columbia: Bull. 285, pp. 194–200, 1906. Exhausted.
——— and HARDER, E. C., Iron ores of the Iron Springs district, southern Utah: Bull. 338, 102 pp., 1908.
PAIGE, SIDNEY, The Hanover iron-ore deposits, New Mexico: Bull. 380, pp. 199–214, 1909. Exhausted.
STEBINGER, EUGENE, Titaniferous magnetite beds on the Blackfeet Indian Reservation, Mont.: Bull. 540, pp. 329–337, 1914.

CUBAN IRON ORES.

SPENCER, A. C., Manganese deposits of Santiago, Cuba: Bull. 213, pp. 251–255, 1903. 25c.
——— Three deposits of iron ore in Cuba: Bull. 340, pp. 318–329, 1908.

IRON ORES IN GENERAL.

BIRKINBINE, JOHN, Iron ores: Mineral Resources of U. S., annual volumes from 1886, 1887, and 1889 to 1905, inclusive. 50c. to $1.20.
——— The production of iron ores in various parts of the world: Sixteenth Ann. Rept., pt. 3, pp. 21–218, 1894. $1.20.
BURCHARD, E. F., Iron ore, pig iron, and steel: Mineral Resources U. S. for 1911, pt. 1, pp. 119–190, 1912. 90c.
——— Iron ore, pig iron, and steel: Mineral Resources U. S. for 1912, pt. 1, pp. 147–202, 1913. 90c.
ECKEL, E. C., Iron ores of the United States: Bull. 260, pp. 317–320, 1905. Exhausted.
HARDER, E. C., The production of iron ore, pig iron, and steel in 1908: Mineral Resources for 1908, pt. 1, pp. 61–134, 1909. 80c.
HAYES, C. W., Iron ores of the United States: Papers on the conservation of natural resources: Bull. 394, 214 pp., 1909. 40c.
SWANK, J. M., American iron trade: Mineral Resources U. S., annual voulmes, 1882 to 1904, inclusive. 50c. to $1.20.
——— Iron and steel and allied industries in all countries: Eighteenth Ann. Rept., pp. 51–140, 1896. $1.
Geologic Atlas of the United States, folios which contain sections on iron ores:[1] Nos. *2*, *4*, 5, *6*, *8*, *10*, 11, 12, 14, 18, *19*, 20, 21, 22, 24, 25, 28, *32*, *33*, *35*, 36, 37, 40, 43, 44, 55, 56, 59, 61, *62*, *64*, 70, 72, *78*, 82, 83, 84, 90, *91*, 95, 101, 115, 116, 118, 120, 121, 124, 125, 126, 129, 135, 138, 139, 143, *151*, *157*, *161*, *170*, 171, 174, *175*, 178, 179, 182, *183*, 184, 187, *191*, *196*.

[1] Number of folios containing important notes on iron ores are printed in italics.

STATE SURVEY PUBLICATIONS ON IRON ORES.

Some of the publications on iron ore issued by States in which important iron-ore deposits are situated are given in the following list. It should be noted here that the United States Geological Survey does not distribute these publications. For further information concerning them application should be made to the respective State geologists or to officials of the State organization which issued the publication.

Alabama:

PHILLIPS, W. B., Iron making in Alabama: Alabama Geol. Survey Rept., 3d ed., 1912.

California:

AUBURY, L. E., Iron: California State Min. Bur. Bull. 38, p. 297, 1906.

Georgia:

MCCALLIE, S. W., Preliminary report on the iron ores of Georgia: Georgia Geol. Survey Bull. 10, p. 100, 1900.

——— Report on the fossil iron ores of Georgia: Georgia Geol. Survey Bull. 17, 1908.

Kentucky:

MOORE, P. N., Report on the iron ores in the vicinity of Cumberland Gap: Kentucky Geol. Survey Rept., new ser., vol. 4, pp. 241–254, 1878.

——— Report on Bath and Fleming counties, Ky.: Kentucky Geol. Survey, 1886.

——— Iron ores of the Red River, Cumberland, and Hanging Rock regions, Kentucky: Kentucky Geol. Survey, Eastern Coal Fields C, 123 pp., 1884.

Maryland:

SINGEWALD, J. T., Report on the iron ores of Maryland: Maryland Geol. Survey, vol. 9, pt. 3, pp. 123–337, 1911.

Minnesota:

VAN BARNEVELD, C. E., Iron mining in Minnesota: Minnesota School of Mines Experiment Station Bull. 1, 215 pp., University of Minnesota, Minneapolis, 1912.

WINCHELL, N. H., and H. V., The iron ores of Minnesota: Minnesota Geol. and Nat. Hist. Survey Bull. 6, 429 pp., 1891.

Missouri:

CRANE, G. W., The iron ores of Missouri: Missouri Bur. Geology and Mines Bull. 10, 2d ser., 434 pp., 1912.

NASON, F. L., Iron ores of Missouri: Missouri Geol. Survey Rept., vol. 2, 1892.

New Jersey:

BAYLEY, W. S., Iron mines and mining in New Jersey: New Jersey Geol. Survey, vol. 8, 1910.

New York:

NEWLAND, D. H., and KEMP, J. F., Geology of the Adirondack magnetic iron ores (New York): New York State Mus. Bull. 119, 1908.

NEWLAND, D. H., and HARTNAGEL, C. A., Iron ores of the Clinton formation in New York State: New York State Mus. Bull. 123, 1908.

SMOCK, J. C., Iron mines and iron-ore districts in the State of New York: New York State Mus. Bull. 7, 1889.

North Carolina:

NITZE, H. B. C., Iron ores of North Carolina: North Carolina Geol. Survey Bull. 1, 239 pp., 1893.

Ohio:

ORTON, EDWARD, The iron ores of Ohio, considered with reference to their geologic order and geographic distribution: Ohio Geol. Survey, vol. 5, pp. 371–435.

Pennsylvania:

LESLEY, J. P., and D'INVILLIERS, E. V., Pennsylvania Second Geol. Survey Ann. Rept., pp. 401–570, 1887.

MCCREATH, A. S., Analyses of iron ores of Pennsylvania: Pennsylvania Second Geol. Survey Rept. M3, pp. 1–55, 1879–80.

Tennessee:

BURCHARD, E. F., The red iron ores of Tennessee: Tennessee Geol. Survey, 116 pp., 1913.

Texas:

COMSTOCK, T. B. A preliminary report on the central mineral region of Texas: Texas Geol. Survey First Ann. Rept., pp. 239–391, 1890.

——— Report on the geology and mineral resources of the central mineral region of Texas: Texas Geol. Survey Second Ann. Rept., pp. 555–664, 1891.

KENNEDY, W., and others, Report on the iron-ore district of eastern Texas: Texas Geol. Survey Second Ann. Rept., pp. 7–326, 1891.

PENROSE, R. A. F., jr., A preliminary report on the geology of the Gulf Tertiaries of Texas from Red River to the Rio Grande: Texas Geol. Survey First Ann. Rept., pp. 3–100, 1890.

Virginia:

WATSON, T. L., Mineral resources of Virginia (Iron, by R. J. Holden, pp. 402–491). The Virginia Jamestown Exposition Commission, 1907. (Application should be made to the State geologist at Charlottesville.)

Wisconsin:

CHAMBERLIN, T. C., Clinton iron-ore deposits: Geology of Wisconsin, 1873 to 1877, vol. 2, p. 327, and atlas.

WEIDMAN, S., The Baraboo iron-bearing district of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 13, 1904.

COBALT.

By Frank L. Hess.

PRODUCTION.

No cobalt was produced from domestic ore in the United States during 1913. The cobalt used in the making of high-speed steels and stellite was imported either as metal from Germany or as oxide from Canada. Probably the great source of the German cobalt is from crude copper produced by the Union Minière du Haut Katanga, in Belgian Kongo, Africa, of which 8,064 short tons was produced and shipped to Germany for refining during 1913.[1] The crude copper contained 2.8 to 3.25 per cent of cobalt (some ran much higher in 1912), and if 3 per cent were the average content of cobalt the total was about 242 tons of metallic cobalt. This makes a by-product comparatively easily saved in electrolytic refining.

In Canada considerable quantities are found with the silver ores at Cobalt, Ontario, but owing to the few known uses for cobalt only a small part of the mined cobalt minerals have been utilized. Dr. H. T. Kalmus was commissioned by the mines branch, bureau of mines, Canada, to investigate the use of cobalt, and in a preliminary report [2] he says:

> The mining companies receive very little return for the cobalt content of the silver ores of the cobalt district. There have been about 175,000 tons of silver-bearing ore shipped from the cobalt district since 1904, carrying approximately 7,000 tons of cobalt, which, at a reasonable market value for metallic cobalt, should have been worth in the neighborhood of $10,000,000. For this the mine owners received only $566,000. Much of this cobalt is lying as residues, etc., at the smelters, for practically the only market which it finds is a limited one for the use as blue coloring substance. For this purpose the smelters ship black cobalt oxide, which consumes about one-third of the present output of the camp, leaving to be cared for the remaining two-thirds and the surplus from other years. Thus there is a potential value of many millions of dollars in the cobalt metal of Ontario which is not being realized.
>
> Waste products running high in cobalt may be obtained in a variety of forms from the smelters, but inasmuch as the process for the production of fairly pure cobalt oxide has been very completely worked out and is being practiced on a large scale by the Canadian Copper Co., Copper Cliff, Ontario; the Deloro Mining & Reduction Co., Deloro, Ontario; the Coniagas Reduction Co., Thorold, Ontario; and the Canada Refining & Smelting Co. (Ltd.), Orillia, Ontario, it seemed advisable to use this oxide as an initial substance.

The International Nickel Co. has made cobalt oxide at its plant at Bayonne, N. J., but the following notice appeared in the New York Commercial of January 19, 1914:

> The discontinuance of the manufacture of cobalt oxide by us leaves consumers largely dependent upon the product of German and other European manufacturers.

[1] Ball, S. H., and Shaler, M. K., Mining in the Belgian Congo in 1913: Min. and Sci. Press, vol. 108, pp. 320–325, 1914. Also personal communication.

[2] Kalmus, H. T., The metal cobalt and its alloys: Canadian Min. Jour., Dec. 15, p. 794. 1913.

The shutting off of production was largely due to the fact that we were unable to make profit on the item. A constantly increasing supply of cobalt was available from the regions in and around Ontario and this resulted in a lowering of prices, as demand for the article was only nominal. Our average annual output of cobalt oxide amounted to about 12,000 pounds.

W. B. LAWSON, *International Nickel Co.*

Considerable cobalt-rich speiss made from cobalt ores is known to be held at various smelters in this country, but it is known that experiments looking toward its extraction have apparently been successful and it is probable that its production as a by-product will be accomplished during 1914.

No production of cobalt ores is known to have been made in New Caledonia during 1913. The ores are too lean to compete with the by-product cobalt from Cobalt and Katanga.

IMPORTS.

The imports for consumption of cobalt oxide, ore, and zaffer into the United States since 1906 have been as follows:

Cobalt oxide, ore, and zaffer imported into the United States for consumption, 1906–1913, in pounds.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
1906	41,084	$83,167	1910	14,935	$6,352
1907	48,013	74,849	1911	602,454	59,151
1908	219,098	17,677	1912	791,242	83,080
1909	12,132	11,096	1913	209,396	95,735

No record is kept of the imports of metallic cobalt. The price of cobalt during 1913 was nominally, as in 1912, about $1.90 to $2 a pound.

MOLYBDENUM.

By Frank L. Hess.

No commercial production of molybdenum is known to have been made in 1913, and no promising new deposits were reported during the year. The demand, however, suddenly increased, and in the latter part of the fall a French firm offered the following prices for molybdenite:

Percentage of MoS_2:	Price per unit in long tons.	Percentage of MoS_2—Continued.	Price per unit in long tons.
59	$5.00	80	$8.50
60	6.00	90	10.00
70	7.00	95	12.00

Still higher prices were quoted in some of the technical journals. In Queensland £326 ($1,586) a long ton was paid for high-grade molybdenite in December, 1913.[1]

Earlier in the year Australian molybdenite of high grade had sold in this country for 45 cents a pound.

Some ore was brought to this country from British Columbia for concentration and was shipped abroad. No record is kept of the molybdenum ores imported. Both metallic molybdenum (powder) and ferromolybdenum are made in this country, besides the very refined ductile metal made by the General Electric Co. The metallic powder sold for about $1.50 a pound.

Molybdenum and ferromolybdenum, valued at more than $200 a ton, were imported during 1913 to the extent of 7.8 short tons, valued at $15,939, against 3.9 tons, valued at $1,670, in 1912.

[1] Min. Eng. Rev. (Melbourne), vol. 6, p. 170, 1914.

NICKEL.

By Frank L. Hess.

PRODUCTION.

GENERAL CONDITIONS.

No nickel ores, as such, were mined in the United States during 1913. Although this country refines more nickel than any other country, the ore practically all comes from Ontario and New Caledonia. It is reduced to matte and shipped here for further reduction to metal. The only domestic production is from blister copper, from which it is obtained as a by-product in electrolytic refining, and even this small quantity is so mixed as to source that what part of it is of domestic and what part is of foreign origin can not be told.

CANADIAN PRODUCTION.

The Canadian production and exports since 1909 have been as follows:[1]

Canadian production and exports of nickel ores, 1909–1913.

	1909	1910	1911	1912	1913
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Ore mined	451,892	652,392	612,511	737,584	784,697
Ore smelted	462,336	628,947	610,834	725,065	823,403
Bessemer matte produced	25,845	35,033	32,607	41,925	47,150
Copper content of matte	7,873	9,630	8,966	11,116	12,938
Nickel content of matte	13,141	18,636	17,049	22,421	24,838
Spot value of matte	$3,913,017	$5,380,064	$4,945,592	$6,303,102	$7,076,945
Nickel contained in matte, etc.:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Exported to Great Britain	3,843,763	5,335,331	5,023,393	5,072,867	5,164,512
Exported to United States	21,772,635	30,679,451	27,596,578	39,148,993	44,224,119
Exported to other countries					70,386
	25,616,398	36,014,782	32,619,971	44,221,860	49,459,017

BY-PRODUCT NICKEL PRODUCTION.

Nickel in the form of nickel sulphate and as metallic nickel is saved from the electrolytes used in refining blister copper. Most if not all blister copper carries a little nickel which goes into solution and

[1] McLeish, John, Preliminary report on the mineral production of Canada in 1913: Canada Dept. Mines, Mines Branch, p. 13, 1914.

gradually accumulates in the electrolyte. During 1913 an equivalent of 481,565 pounds of nickel, valued at $79,393, was thus saved by the refineries. About one-fourth of the product was produced as electrolytic nickel.

IMPORTS.

The imports of nickel for consumption into the United States from 1909 to 1913, inclusive, as reported by the Division of Statistics, Bureau of Foreign and Domestic Commerce, have been as follows:

Imports of nickel for consumption into the United States, 1909–1913, in pounds.

	Nickel, nickel ore and matte, nickel oxide, alloys of nickel with copper, etc.[a]		Value of manufactured articles of nickel.	Total value.
	Quantity.	Value.		
1909	22,194,102	$3,034,407	$1,866	$3,036,273
1910	32,373,251	4,213,079	14,759	4,227,838
1911	29,829,268	4,022,716	27,314	4,050,030
1912	46,317,078	5,724,431	34,536	5,758,967
1913	47,446,520	6,562,555	38,200	6,600,755

[a] Includes only the nickel content of ore and matte. No ore is known to have been imported into the United States in 1911, 1912, or 1913.

The imports for 1913 were divided as follows:

Imports of nickel for consumption into the United States in 1913, in pounds.

	Quantity.	Value.
Nickel, alloys, pigs, bars, etc	335,054	$134,303
Ore and matte, nickel content	47,109,930	6,427,639
Nickel oxide	1,536	613
Total	47,446,520	6,562,555

The United States import records show that 47,109,930 pounds of nickel were imported in matte and ore during 1913, and the Canadian figures give the quantity exported in matte to the United States as 44,224,119 pounds. The difference, 2,885,811 pounds, is presumably the approximate quantity contained in matte made from New Caledonian ores and shipped to this country to be refined by the United States Nickel Co., at New Brunswick, N. J.

EXPORTS.

The United States refines much more nickel than it can use, so that, although not an important producer, it is a large exporter. Exports since 1906 have been as follows:

Exports of nickel, nickel oxide, and matte from the United States, 1906–1913, in pounds.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
1906	10,620,410	$3,493,643	1910	15,244,937	$4,704,088
1907	8,772,578	2,845,663	1911	[a]25,099,586	8,283,777
1908	9,770,248	3,297,988	1912	[a]25,815,016	8,515,332
1909	12,048,737	4,101,976	1913	[a]29,173,088	9,686,794

[a] No nickel matte is known to have been exported during 1911, 1912, or 1913.

PRICES.

The price during the year varied from about 35 to 45 cents a pound, depending on quantities. The lowest price, about 35 cents, is said to be made with large users, who sign exclusive contracts for a term of years with an agreement not to resell.

TIN.

By Frank L. Hess.

PRODUCTION.

Tin is one of the few metals abundant in some other parts of the world which is not also abundant in the United States. An equivalent of only 84 short tons of tin ore, carrying 60 per cent metallic tin, valued at $36,970, was produced in the United States during 1913, against an equivalent of 147 tons of 60 per cent ore, valued at $124,800, in 1912.

The largest quantity of tin was taken out by the York Dredging Co., on Buck Creek, Alaska. Smaller quantities were taken out by A. Bock, J. G. Southerland, and Joe Eglar, at Tofty, Alaska; J. L. White, Tinton, S. Dak., and the Cherokee Tin Mining Co., at Gaffney, S. C. All was from placers, that from South Carolina being from a residual placer and the others from stream gravels.

The world's tin deliveries for 1913, as compiled by C. Mayer, secretary of the New York Metal Exchange, which approximate both production and consumption of new metal, were as follows:

Tin deliveries, 1911–1913, in short tons.[a]

	1911	1912	1913
London deliveries	17,643	20,823	20,045
Continent of Europe	24,671	29,820	28,707
Cornwall (production)	5,936	6,160	6,496
Bolivia (shipments)	25,312	23,744	27,832
South Africa (shipments)	3,248	3,472	3,584
China (shipments)	1,680	2,576	2,744
United States (receipts)	51,892	57,557	51,017
	130,382	144,152	140,425
Deductions of Straits, etc., from Continent and English, Bolivian, etc., arriving in the United States	6,832	9,598	10,416
	123,550	134,554	130,009

[a] Statistical review of the domestic and foreign metal markets, 1913, p. 11, 1914.

These figures are issued soon after the close of the year, are therefore only approximate and hence subject to more or less revision.

The Cornish output is estimated by the Mining Journal, London,[1] at 5,000 long tons (5,600 short tons). The same paper credits Nigeria with a production of 3,577 tons, and South Africa with an equivalent of 2,070 tons of metallic tin. The Chinese shipments from Hongkong were reported by George E. Anderson[2] as 4,335 short tons (116,075 slabs of 112 pounds each).

[1] Jan. 17, 1914, p. 65.

[2] Daily Cons. and Trade Repts., Mar. 26, 1914, p. 1148.

The Federated Malay States (referred to as the Straits, or Straits Settlements) produce by far the greatest quantity of tin, and nearly all of it comes from alluval deposits, only a little being obtained from veins. During 1913 the shipments amounted to 56,142[1] short tons, against 54,231 tons in 1912. The Federated Malay States produce much more tin than any other country, and the output is practically all from placers. Dredging is now an important and growing mode of tin mining, and concerning it the following editorial from the Malayan Tin and Rubber Journal, Ipoh, Federated Malay States, is quoted in the Daily Consular and Trade Reports of July 27, 1914:

Mining methods are undergoing a gradual change in this part of the world by the introduction of the dredging system, which we believe is to have an effect upon the industry that at the moment is barely realized. We have gone carefully into the question and are led to the conviction that tin in the next two years will reach a level considerably lower than the average of the last two years.

Nineteen dredges have been placed on various properties in Malaya and Siam Dredges are to be laid down as follows: Malayan tin, 4, probably 5; Chenderian. Valley, 1; Ipoh tin dredging, 1; Kampong Kamunting, 2; Kamunting, 1, probably 2, Larut, 1; Tekka Taiping, 2, probably 3; Pahang, 1, probably 2; Bruas, 1; Debook Group, 1; Siamese tin, 1, probably 2; Renong, 1; undesignated, 2. That gives a total of 19 certain, and an additional 19 likely to be laid down. The "probables" actually reach 24, for in addition to the Taiping and Siamese propositions mentioned there is every chance of two other dredges being laid down in Taiping and three in Siam. All this in a way is a healthy sign * * * but it also means a greatly increased output, a conservative estimate of the monthly output of the average dredge being 400 piculs (26⅔ short tons).

The Bolivian ore is all from veins, and that country is by far the largest producer of lode tin.

PRICES.

Tin prices in New York, based on Straits tin, from 1909 to 1913 were as follows:

Average monthly prices, in cents per pound, of Straits tin in New York.[a]

	1909	1910	1911	1912	1913
January	28.13	32.74	41.39	43.24	50.425
February	28.30	32.96	42.83	43.46	48.63
March	28.74	32.49	40.76	42.86	46.835
April	29.48	33.02	42.20	44.02	49.12
May	29.16	33.18	43.10	46.12	49.07
June	29.32	32.84	46.16	47.77	44.82
July	29.17	33.04	42.96	44.75	40.27
August	30.04	34.10	43.45	45.87	41.668
September	30.35	35.23	39.98	49.18	42.375
October	30.50	36.63	41.21	50.11	40.41
November	30.90	36.68	43.13	49.90	39.805
December	33.06	38.28	44.97	49.90	37.62
Average	29.76	34.27	42.68	46.43	44.225

[a] Statistical review of the domestic and foreign metal markets, 1913, p. 15, 1914.

According to figures compiled by the Division of Statistics, Bureau of Foreign and Domestic Commerce, the United States during the year 1913 imported for consumption 53,315 short tons of tin, valued at $46,946,756; tin foil, valued at $188; all other manufactures of tin, $336,746; and black oxide of tin or cassiterite (including 1.6 tons

[1] Far Eastern Review, Mar., 1914, p. 431.

"tin ore"), 26.3 tons, valued at $11,360. The total value of tin imports amounted to $47,295,050. The imports of tin for consumption were the third largest on record and amounted to about 40.8 per cent of the world's production.

The imports of metallic tin for consumption into the United State for the last eight years have been as follows:

Tin imported and entered for consumption in the United States, 1906–1913, in short tons.[a]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1906	50,477	$37,447,315	1910	52,528	$33,913,255
1907	41,257	32,074,263	1911	53,527	43,346,394
1908	41,267	23,923,560	1912	58,016	50,372,478
1909	47,662	27,558,546	1913	[b] 53,315	46,946,756

[a] These figures do not include the tin contained in imported ore, tin foil, or other manufactures.
[b] Includes 986 tons of "scrap tin," valued at $19,543.

TITANIUM.

By Frank L. Hess.

Virginia produced all the American output of rutile in 1913, the American Rutile Co. being the only producer in the United States. This company controls and works the well-known deposits at Roseland, Nelson County, Va. During the year the company produced 305 tons of rutile, carrying 94 to 96 per cent of titanium dioxide (TiO_2), and valued at about $49,000. The portion of the deposits worked contains considerable ilmenite and this is removed from the concentrates by a Wetherell magnetic separator, about 250 tons of ilmenite being thus produced during the year. The 10-stamp mill was operated continuously from March to the end of the year.

Not all the rutile concentrate was sold, but it is said the demand promises to be better than heretofore, and foreign firms are showing much interest. Prices ranged from $160 to $200 a ton, according to quantity and purity. The highest price is paid for pulverized material for the ceramic trade. A large part of the rutile produced in 1913 was used in the manufacture of titanium-carbide electrodes for arc lamps. There has not been so large a demand as formerly for rutile to be used in the manufacture of ferrotitanium.

A part of the separated ilmenite has been sold for use in making electrodes for electric lights, and experiments with the electric furnace point to the possible use of ilmenite in the direct production of tool steel.

TUNGSTEN.

By Frank L. Hess.

GENERAL CONDITIONS.

The production of tungsten ore in the United States during 1913, as estimated from returns made to the United States Geological Survey, was equivalent to 1,537 short tons [1] of ore carrying 60 per cent of tungsten trioxide (WO_3), with a value of $672,118. The output for the three preceding years was: In 1912, 1,330 tons, valued at $502,158; in 1911, 1,139 tons, valued at $407,985; and in 1910, 1,821 tons, valued at $832,992.

Tungsten ores were shipped from Arizona, California, Colorado, Idaho, Nevada, New Mexico, South Dakota, and Washington. As heretofore, Colorado made the largest production, and its entire output of 953 tons, valued at $428,760, came from the Boulder tungsten field. California made the second largest output, mostly from Atolia, San Bernardino County.

Ferberite, wolframite, hübnerite, and scheelite were mined. The Boulder tungsten field production is ferberite, and as before stated in these reports, the district is unique in that it is the only large ferberite-producing district in the world. A small quantity of a wolframite, which is probably ferberite, was mined near Hill City, S. Dak.

Wolframite was shipped from Arivaca, Ariz., and from the Clark Mountain district of California.

Hübnerite was shipped from the Blue Wing district, Patterson Creek, Idaho; the dry placers near Dragoon, Ariz.; Nogales, Ariz.; White Oaks, N. Mex.; and a little from Jawbone Canyon, Kern County, Cal.

Scheelite was shipped from Oracle, Ariz.; Atolia and Randsburg, Cal.; and from the Snake Range, Nevada. The Atolia district makes a larger production of scheelite than any other district in the world. Much the larger part of the production of the district is that made by the Atolia Mining Co., and, as in 1912, this company was the largest individual producer in the United States.

Alaska.—No production of tungsten ores was made, but tin ore (2.5 tons) produced by the Jamme Syndicate on Lost River carried 11.08 per cent tungsten (13.98 WO_3).

Arizona.—The Cody-Dyer Mining & Milling Co. produced some scheelite in the Old Hat district in the Oracle Mountains, 40 miles northeast of Tucson. From the dry placers 4 miles north of Dragoon, as in former years, a few thousand pounds of hübnerite were produced.

[1] The short ton of 2,000 pounds is used throughout this article.

A small lot of hübnerite was shipped from Nogales by F. J. Hobson, and A. L. Pelligrin shipped a quantity of wolframite from Las Guigas Mountains near Arivaca to Denver for concentration. On account of its light color, this mineral has generally been called hübnerite, Mr. Pellegrin has written that the iron content equals that of manganese, so that the mineral is really wolframite.

Exploitation of ferberite deposits at Cavecreek, 30 miles north of Tucson, was begun by the Pittsburgh Tungsten Mines Co., but no production was made. The ferberite was analyzed by Dr. Edgar T. Wherry, who obtained the following result:

Analysis of ferberite from Cavecreek, Ariz.

Tungsten trioxide (WO_3)	73.74
Ferrous oxide (FeO)	17.41
Manganous oxide (MnO)	4.76
Lime (CaO)	.24
Cuprous oxide (CuO)	1.07
Magnesia (MgO)	None.
Tantalum and columbium pentoxides ([Ta, Cb]$_2O_5$[a])	2.19
Silica (SiO_2)	.72
	100.13

The ferberite is accompanied by a hydrous copper tungstate which is now under investigation in the Geological Survey.

No production was made from the Williams tungsten claims, formerly the Williams & Pittman property, in the Aquarius Mountains, 12 miles east of Owens, and 3 miles southwest of Kingman, Ariz. The year was spent in the construction of a road and mill. Twenty miles of road were built, and it is stated that an automobile can now run from Kingman directly to the property.

California.—As in former years, the bulk of the production was from the Atolia district and mostly from the mines of the Atolia Mining Co. Its East Union mine is holding out well and is being worked at a depth of more than 600 feet. Some ore has been found in the eastward extension of the Papoose vein, and ore was taken out of several claims.

Some scheelite was also taken from the White Flower claim at Atolia; a little from the Sidney gold mine, 5 miles east, on the west side of the Rand Mountains; and some from the claims of A. M. Powell, across the range from the Sidney group. The last two properties are in the south end of the Stringer district. Nearer Randsburg, but also in the Stringer district, scheelite was mined by Thompson & Skinner on claims adjoining the Baltic. Some high grade scheelite was taken from the Winnie claim, on which gold mining is also prosecuted, and a small production of high grade scheelite was made from a placer on the Baltic claim.

In the Randsburg district the Consolidated Mines Co. produced a small tonnage of scheelite from its gold mine.

About 30 miles west of Randsburg, in Jawbone Canyon, a small production of hübnerite is reported to have been made. A specimen from the claim shows a mixture of scheelite with a darker mineral which is probably hübnerite.

A small quantity of wolframite was mined by the Ri-Cal Tungsten Syndicate, R. M. Whitman, and the United States Tungsten Mining

[a] As judged from the density of the oxide, approximately 1.50 Ta_2O_5 and 0.69 Cb_2O_5.

& Products Co. in the Clark Mountains, New York mining district, in the east side of San Bernardino County.

Some development work was done on scheelite claims near Weldon, Kern County, but no shipment was made. The Union Hill Mining Co., at Grass Valley, saved some scheelite during the course of gold mining, but made no shipments.

Colorado.—As stated, tungsten mining in Colorado was confined as usual to the Boulder tungsten field, and amounted to an equivalent of 953 tons of ore carrying 60 per cent of tungsten trioxide (WO_3), valued at $428,726.

As usual, the Primos Mining & Milling Co., and the Wolf Tongue Mining Co. were the largest producers. Both own large tracts of tungsten-bearing land. The Primos Mining & Milling Co. deepened its inclined shaft on the Conger claim during the year. Work on the Lone Tree claim was stopped in the spring, and work was taken up on the Corkscrew claim on the west of the Lone Tree. The "Corkscrew" claim receives its name from the erratic way in which the vein changes its strike and dip. The Quaker City claim was worked until July. The company's mill at Lakewood was run throughout the year. During the first part of the year the company bought some ore, but during the rest of the year the mill was run on the company's ore.

About 25 men were employed at Sugar Loaf, in which part of the field the principal production was made from the Lord Byron claim.

The Wolf Tongue Mining Co. operated its tungsten properties through lessees. In 1912 the company furnished its lessees with electric hoists, free of charge, the lessees having to pay only for the current used. The company also paid a certain rate per foot for sinking and drifting. The tungsten market was not very tempting at the time, but this policy induced a number of men to start work on various parts of the company's lands. In 1913 the company offered further advantages to lessees by putting up a centrally located compressor plant and piping compressed air to the various parts of its properties on which lessees were working or were willing to work. The compressor is electrically driven, and air is furnished lessees at or near cost; they thus may have the advantage of a mechanical hoisting plant and compressed air for drilling without the initial expense of installing a plant.

Remarkably rich ore is reported to have been found in the Cold Spring vein belonging to the Wolf Tongue Mining Co.

Ten sublessees worked upon the Tungsten Mining, Milling & Exploration Co.'s property which was leased in 1912 to the Wolf Tongue Mining Co.

The latter company's mill at Nederland was operated through the year.

The Colorado Tungsten Mining & Milling Co. operated irregularly through the year. Its mill was operated only part of the time.

Two sets of lessees worked on the Barker tract and produced some ore.

Ardourel & Smith ran their mill all the year on tailings from the Wolf Tongue Mining Co.'s mill. No ore was milled.

On the Rogers tract, controlled by Eugene Stevens, considerable work was done by lessees, and good ore is reported to have been cut

at several places. The Boulder Tungsten Production Co. made a small output during the year.

The Park's Tungsten Co., whose property is located between Nederland and Boulder, operated through the year and hauled its ore to the Eureka Mill (Mann & Mann) at the mouth of Boulder Canyon.

Some production was made by the Manchester Mining Co. from the claims formerly held by Howell & Lightbourner, in Gilpin County, about 4 miles south of Nederland. These claims are at the southern end of the Boulder tungsten field.

Idaho.—The Idaho Tungsten Co., which leases the property of the Ima Consolidated Mining & Milling Co., operated its mines on Patterson Creek in the Blue Wing district, Lemhi County, Idaho, during a part of the year and made two shipments of concentrates. The tungsten mineral is hübnerite, which is found in quartz veins occupying fault fissures and carrying besides the hübnerite, lead, zinc, copper, and silver minerals, fluorite, pyrite, and muscovite. The country rocks are quartz schists and slates. There are a considerable number of veins ranging from thin stringers to veins 11 or 12 feet wide. Some of the veins are lean, but lenses in others are very rich. Leadore, on the Gilmore & Pittsburg Railroad, is the nearest railroad shipping point and is distant about 20 miles in an easterly direction. The wagon road has been recently constructed and has some heavy grades, making travel over it so difficult that the concentrates are hauled to Arco, a station on the Mackay branch of the Oregon Short Line, about 90 miles south. Freight hauled over the Arco road in either direction costs about $20 a ton. The company has a concentrating mill at the mines.

E. M. Smith shipped a small quantity of scheelite from the Friday group of claims near Murray, Idaho.

Nevada.—A small quantity of hübnerite was produced by the Shoshone Tungsten Mining Co. at Round Mountain, Nye County.

On Snake Creek, Bonita district, White Pine County, J. D. Tilford & Co. commenced work on scheelite-bearing veins. An experimental mill, with a capacity of 2 tons each 24 hours, was put up, and a shipment of concentrates was made. Baker is the nearest post office.

Some prospecting was done on a scheelite deposit 6 miles southwest of Ruby Valley post office, on Ruby Lake, in Elko County, but no production is known to have been made. The deposit also carries some bismuth.

Nothing is known to have been done during the year on the property of the United States Tungsten Corporation at Hub, near Osceola, White Pine County; on the scheelite claims at Browns and Rebel Creek, Humboldt County; on the wolframite claims 12 miles southwest of Pioche, Lincoln County; or on other tungsten-bearing claims of the State, of which a number are known.

New Mexico.—A few tons of hübnerite, which appears jet black in the hand specimen, was concentrated from tailings from gold ore on the Wild Cat lease at White Oaks, Lincoln County. Although black in the hand specimen, the mineral has a green streak, and in very thin sections has a green color by transmitted light. The analysis shows only a fraction of a per cent of iron.

Prospecting and a little mining was done on a wolframite-bearing vein on Copper Mountian in the Copper Mountain district (also known as the Picuris or Copper Hill district), Taos County, near Barranca, by Joe Peyer and Frank Gallup, but no ore was sold during the year. The wolframite is accompanied by copper minerals, iron pyrites, and a number of nonmetallic minerals.

South Dakota.—The only tungsten ore produced in South Dakota in 1913 was a small tonnage put out by the Black Hills Tungsten Mining & Milling Co., of Hill City. The claims are located between Hill City and Keystone, Pennington County, on a group of 12 quartz veins which are said to reach as much as 3 or 4 feet in width. The quartz is exceedingly hard and glassy, and carries some pyrite and tourmaline with the wolframite. A mill with an estimated daily capacity of 50 tons, a shop, and a laboratory were erected, air drills were installed, and several shafts were sunk to depths of 70 to 92 feet. Considerable drifting and crosscutting was also done.

Washington.—No tungsten mining is known to have been done during 1913 in Washington, but a small lot of hübnerite concentrated in 1912 from its property near Loon Lake was shipped by the Consolidated Tungsten Co.

MARKET CONDITIONS.

The demand for tungsten ores during 1913 was fairly good, but the supply was fully equal to the demand. The price for ferberite was about $7.50 per unit during the year, but the producers of the Boulder field are able to meet almost any demand the market makes, and small lots from other places are not apt to bring so good a price. Ferberite is easily smelted, especially in the electric furnace, and there is a tendency to prefer it to hübnerite and scheelite, because if these ores are used a difference must be made in the fluxing; hence so long as the ferberite can be obtained, smelters prefer it. The result is that scheelite and hübnerite or wolframites with copper minerals bring somewhat lower prices, especially in small lots. In the older process of treating the ores with a mineral acid to obtain tungsten trioxide, which is then reduced, no such objections obtain.

First-class metallic tungsten in the form of powder sold during most of the year at 74 to 75 cents a pound. For a part of the latter half of the year it was probably a cent or two lower.

TUNGSTEN RESOURCES.

It is probable that the tungsten resources of the country are considerably larger than have been generally realized. Many new deposits have been discovered in various parts of the Western States, and, should prices increase, it is probable that the output could soon be increased much above the record of 1910, when 1,821 tons were marketed. Most of these new discoveries are not sufficiently developed to show how large an output can be made from them; but it is probable that some will prove to be of considerable extent, and one or two new large producers would make a noticeable difference in the American market. Similar discoveries will probably be made in other parts of the world, and they may be large, as witness the sudden heavy production which has come from Burma during several

years. The Burmese production has been from placers the extent of which is not well known; but many veins also have been found in the field, and their potential productivity is likewise apparently large. It is also not at all sure that extensions of the fields now known or new fields may not be discovered.

USES OF TUNGSTEN.

The great use of tungsten is as an alloy of high-speed steel—that is, steel used for making tools used in metal-turning lathes running at high speed—to which tungsten imparts the property of holding its temper at higher temperatures than will carbon steels. In such steels from 16 to 20 per cent of tungsten is used. Saw blades are made which contain 1 to 2 per cent tungsten. The use of tungsten in magnet steels has consumed large quantities, but this use seems to be declining somewhat. The now well-known ductile tungsten is used for incandescent lamps, which are fast displacing carbon lamps. Lately greatly improved lamps, in which the wire is wound in helices and in which the globes are filled with nitrogen, have brought the consumption of electricity down to 0.4–0.5 watt per candle and have produced a close approach to white light. These lamps are furnished in candle powers up to 2,000. Undoubtedly the bulk of the research in the manufacture and use of ductile metallic tungsten has been carried out by the highly efficient corps of scientists under the direction of Dr. W. R. Whitney in the General Electric Co.'s wonderful research laboratories. Dr. C. G. Fink, of the company's staff, gives the probable or possible uses of worked tungsten as follows:[1]

The ductile metal is practically insoluble in all of the common acids; its melting point is higher than that of any other metal; its tensile strength exceeds that of iron and nickel; it is paramagnetic; it can be drawn to smaller sizes than any other metal; and its specific gravity is 70 per cent higher than that of lead. It was natural that a metal with such striking properties as these should soon find application other than that for incandescent lamps.

Wrought tungsten has been substituted with success for platinum and platinum-iridium as contact points in spark coils, voltage regulators, telegraph relays, etc. The service far exceeds that for platinum and platinum-iridium contacts due to the greater hardness, higher heat conductivity, and lower vapor pressure of tungsten as compared with platinum.

Electric laboratory furnaces with tungsten resisters are of two types. In one a tungsten wire is wound on an aluminum tube in an air-tight box with a hydrogen atmosphere. In the second a tungsten metal tube takes the place of the helical carbon resister in an Arsem vacuum furnace.

Tungsten gauze is used successfully for separating solids from acid liquors in the laboratory. This gauze could well be used on a commercial scale; for example, for the removal of sludge from copper refining baths, and for centrifugal apparatus in general whenever acid liquids or acid gases are dealt with. Furthermore, it might be used in apparatus such as described by Cottrell for the removal of sulphuric mist from gases.

Wrought tungsten targets for Roentgen tubes have proved to be one of the most interesting applications.

For thermocouples the tungsten-molybdenum couple is not less interesting. The electromotive force increases with the temperature up to about 540° C. (12½ millivolts), then decreases and passes through 0 millivolts at about 1,300° C. This couple is very convenient for high-temperature measurements in the tungsten-hydrogen furnace.

For standard weights tungsten it also well suited, since wrought tungsten can be made so hard that it will readily scratch glass and still be ductile; furthermore, the density is high (19.3 to 21.4) and it is unaffected by the atmosphere. Tungsten weights remain wonderfully constant.

[1] Metall. and Chem. Eng., vol. 10, pp. 580–581, 1912. A paper delivered before the section of electrochemistry, Eighth Internat. Cong. Applied Chemistry, Sept. 6, 1913.

Besides the applications of tungsten cited above, many others have been but partly worked out and others merely suggested. Owing to its chemical stability the finest sizes of wire down to 0.0002 inch or 0.0005 millimeter in diameter are well adapted for galvanometer suspensions and for cross hairs in telescopes. It has also been suggested to use these fine wires in surgical operations in place of the coarser gold and silver wires. A further suggestion is the use of the wire in musical instruments.

Acid-proof dishes and tubes have been made out of tungsten; futhermore, tungsten wire recommends itself as a unit resistance, since it can be made absolutely pure, can be easily duplicated, and is not corroded.

Since tungsten is paramagnetic and elastic, it is being tried out in electrical meters, replacing the phosphor-bronze springs. Similarly watch springs could be made which would never become magnetized. Finally, tungsten pen points, tungsten drawing dies, tungsten knife blades, tungsten reinforced asbestos curtains and fireproof coverings, etc., were mentioned.

Table of physical and chemical properties of ductile tungsten.

Density, 19.3 to 20.2.
Tensile strength, 322 to 427 kilograms per square millimeter.
Young's modulus of elasticity, 42,200 kilograms per square millimeter (steel 20,000).
Melting point, 3,177° C. (Langmuir); 3,100° ± 60° C. (Pirani & Meyer).
Boiling point, 3,700° C.?
Thermal conductivity 0.35 gram cal. per centimeter per second per 1 degree (Pt. 0.166).
Expansion coefficient 4.3×10^{-6} (Pt. 8.8×10^{-6}.)
Specific heat 0.0358 (Weiss).
Resistivity, hard: 6.2 microhms per cubic centimeter; and annealed 5.0 microhms per cubic centimeter.
Temperature coefficient of resistance, 0.0051 (0°–170°).
Magnetic susceptibility: $+0.33 \times 10^{-6}$ (Honda); that is, practically nonmagnetic.
Hardness 4.5 to 8.0 (Mohs scale).
Insoluble in HCl, H_2SO_4, HNO_3, HF, NaOH, KOH (aq), and mixtures of $K_2Cr_2O_7 + H_2SO_4$, soluble in mixtures of HF and HNO_3 and in fused nitrates and peroxides.
The boiling point of the metal has not yet been determined.

In the discussion of Dr. Fink's paper Dr. Amberg asked whether the alloys of tungsten could also be made ductile, as this might be of great commercial importance. Dr. Fink replied that they had studied various alloys and had found that what was true of tungsten was also true of its alloys. They had not studied the alloy in which Dr. Amberg was most interested, namely, ferrotungsten.

In reply to a question as to the cost of the metal, Dr. Fink said that the cost of pure tungsten is between $10 and $12 a pound.

PRODUCTION.

The production of domestic tungsten ore in 1913 amounted to an equivalent of 1,537 tons of ore carrying 60 per cent tungsten trioxide (WO_3), of which 953 tons was ferberite from Boulder County, Colo., and 542 tons was scheelite from various localities. The remainder was hübnerite and wolframite.

The production of tungsten ore in the United States has been recorded only since 1900; before that time it was insignificant. As obtained by the United States Geological Survey, the figures are as follows:

Production of concentrated tungsten ores in the United States, 1900–1913, in short tons.[a]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1900	46	$11,040	1907	1,640	$890,048
1901	179	27,720	1908	671	229,955
1902	184	34,040	1909	1,619	614,370
1903	292	43,639	1910	1,821	832,992
1904	740	184,000	1911	1,139	407,985
1905	803	268,676	1912	1,330	502,158
1906	928	348,867	1913	1,537	672,118

[a] The production of tungsten ores in this country from year to year can be fairly compared in this table only since and beginning with 1906, as before that date no effort was made to reduce the ores to a common basis of concentration. Since 1906 the ores have been, as far as possible, reduced to an equivalent of ore carrying 60 per cent tungsten trioxide (WO_3), which is the ordinary commercial basis in the United States.

WORLD'S PRODUCTION OF TUNGSTEN.

Figures showing the production in 1913 of the countries mining the largest quantities of tungsten ore are now available in part only.

The world's production of tungsten ore, 1905–1913, by countries, estimated as far as possible in short tons of concentrates containing 60 per cent of tungsten trioxide.

Country.	1905	1906	1907	1908	1909	1910	1911	1912	1913
Africa: South Africa	.....	9	211	40	16	(a)	(a)	(a)	(a)
Asia:									
Burma and the Shan States	.....	.....	.....	.....	.....	407	1,119	2,095	[b] 1,905
Federated Malay States	.....	151	89	83	99	105	[c] 205	[c] 275	.....
French Indo-China (Tonkin)	.....	.....	.....	.....	.....	19	.....	[d] 81	.....
India (not including Burma)	.....	.....	.....	.....	7	[e] 23	.....	(f)	.....
Japan	47	47	71	220	292	275	287	[g] 225	[g] 327
Siam	.....	.....	10	.....	.....	.....	[h] 200	[i] (200)	.....
Australia:									
New South Wales	251	270	451	269	431	413	512	298	[j] 220
Northern Territory	71	230	177	40	49	[k] 78	[k] 71	[k] (71)	.....
Queensland	1,582	865	703	516	679	1,145	750	944	[l] 587

[a] So far as can be learned, no tungsten ore was produced during the years indicated.

[b] The mining position in lower Burma: Min. Jour., London, vol. 105, p. 391, 1914. The writer gives the exports for the year as 1,513 (long) tons. Some of these ores were mixed with tin and were sent to the Federated Malay States for separation. In 1912, Messrs. Radcliff & Co., of Rangoon, estimated that the ores exported carried 65 to 70 per cent WO_3 and the quantity has been reduced to a 60 per cent basis on the supposition that the concentrates average 67.5 per cent WO_3.

[c] Letter from Edwin S. Cunningham, United States consul general, Singapore, giving information obtained from W. E. Kenny, senior warden of mines, Federated Malay States. In 1911, 375,399 pounds of wolframite and 3,414 pounds of scheelite, and in 1912, 500,688 pounds of wolframite and 6,134 pounds of scheelite were produced, mostly from the tin placers in various parts of the States of Perak, Selangor, and Negri Sembilan, though the last State did not produce in 1912. The ore is separated magnetically and is said to carry 60 to 70 per cent WO_3. The ores have been reduced to a 60 per cent basis, on the supposed average of 65 per cent WO_3.

[d] Estimated. The Engineering and Mining Journal, vol. 94, p. 1181, Dec. 21, 1912, prints a translation of an article from the Echo des mines of Nov. 15, 1912, stating that the exports of wolframite from Tonkin for the first half of 1912 were 37 metric tons. This figure has been doubled for the year's output.

[e] Letter from H. H. Hayden, director India geological survey, Aug. 16, 1911.

[f] Only 0.2 of a ton of wolframite was produced in the central part of India in 1912. Hayden, H. H., The mineral production of India during 1912: India Geol. Survey Rec., vol. 43, pt. 2, p. 97, 1913.

[g] Huggins, H. C., Daily Cons. and Trade Repts., Aug. 15, 1914, p. 902. "The production of tungsten ores in Japan amounted to 374,815 pounds, valued at $70,748, in 1912, and 545,642 pounds, valued at $117,030, in 1913." As in previous years, the ores have been considered to carry 72 per cent WO_3.

[h] Weeks, W. G., Notes on mining in Siam, Royal Department Mines, Bangkok, 1912. The figures are for the Siamese year R. S. 130 (corresponding to the year from Apr. 1, 1911, to Mar. 31, 1912), and are given as 3,000 piculs (picul=133⅓ pounds) of wolframite, obtained from the dumps of old tin placers.

[i] Where no data are available the production of the last preceding year for which the figures are obtainable has been introduced to assist in forming an estimate of the production during 1912.

[j] New South Wales, Dept. Mines, Ann. Rept., 1913, Sydney, p. 3, 1914. As given, the figures were: Scheelite, 44.05 long tons; wolfram, 125.75 long tons. For purposes of conversion to a 60 per cent basis, the ores have been considered to carry 70 per cent WO_3, which is the content on which prices are based in Australia.

[k] Trade and customs and excise revenue of the Commonwealth of Australia for the year 1911, Melbourne, p. 355, 1912. The figures given in this work represent the exports only from the port of final shipment, and are probably less than the actual output. The figures given are 1,086 (long) hundredweight wolfram. This is considered as carrying 70 per cent WO_3.

[l] Queensland Govt. Min. Jour., Brisbane, vol. 15, p. 125, Mar., 1914. The figures as given are: Wolfram, 358 long tons, 15 hundredweight; bismuth and wolfram, 181 long tons, 15 hundredweight. For convenience, the bismuth-wolframite mixture is treated as being half wolframite, as no figures are given to show the exact contents. The output is treated as carrying 70 per cent WO_3, the content of tungsten trioxide on which ores are understood to be bought in Australia. Two hundredweight of scheelite were also produced.

The world's production of tungsten ore, 1905–1913, by countries, estimated as far as possible in short tons of concentrates containing 60 per cent of tungsten trioxide—Continued.

Country.	1905	1906	1907	1908	1909	1910	1911	1912	1913
Australia—Continued.									
Tasmania	36	22	46	5	20	75	86	87	[a] 89
Victoria	.....	.....	.....	3	15	31	[b] 33	[c] (33)	.....
Western Australia	.....	.....	1	.....	6	47	[d] 194	[e]	.....
East Indies:									
Billiton	.....	.....	4	11	12	[f] 21	.....	[c] (21)	.....
Singkep	.....	.....	1	14	12	12	.....	[g] 8	.....
Europe:									
Austria	65	63	50	44	43	54	50	[h] 73	.....
England	193	304	361	261	421	307	298	216	[i] 204
France	28	20	67	124	55	33	[j] 188	[j] 252	.....
German Empire (Saxony)	42	57	68	46	106	[k] 105	89	[k] 111	.....
Italy	36	28	18	.....	.....	[e]	[e]	[e]	.....
Portugal	320	629	702	684	609	1,132	1,078	[l] 1,466	.....
Spain	413	222	303	249	142	169	106	[m] 202	[n] 179
Oceania: New Zealand	64	121	153	87	78	187	184	[o] 181	.....
North America:									
Nova Scotia	.....	.....	.....	.....	.....	83	[e]	[p] 17	.....
United States	803	928	1,640	671	1,619	1,821	1,139	1,330	1,537
South America:									
Argentina	.....	326	507	548	900	826	683	[q] 702	.....
Bolivia	75	75	500	187	168	232	370	547	[r] 620
Brazil	.....	.....	.....	16	[e]	[e]	[e]	[e]	.....
Peru	.....	.....	.....	.....	.....	15	57	[s] 241	.....
Total	4,026	4,367	6,133	4,113	5,779	7,615	7,699	9,654	.....

[a] Wallace, W. H. The progress of the mineral industry of Tasmania. Quarters ending June 30 and Dec. 31, 1913, Hobart, 1913 and 1914. As given, the output was 68.1 long tons of wolframite. The percentage of WO_3 is unknown, but is supposed to be about 70, as in Australia.

[b] Annual report of the secretary for mines, Victoria, Melbourne, p. 28, 1912. The production was 17¼ long tons of wolframite concentrates and 15½ hundredweight of mixed wolframite and bismuth concentrates. The latter quantity has been considered as half wolframite, making 25 long tons, which is treated as 70 per cent WO_3.

[c] Where no data are available the production of the last preceding year for which the figures are obtainable has been introduced to assist in forming an estimate of the production during 1912.

[d] Western Australia, Dept. Mines Report, 1911. Perth, p. 11, 1912. The exports were 9 long tons of wolframite.

[e] So far as can be learned, no tungsten ore was produced during the years indicated.

[f] Letter from the Nederlandsche Handels-Maatschappij, dated Oct. 27, 1911.

[g] Report of Singkep Tin Co., quoted in the Mining Journal, London, vol. 100, p. 1249, Dec. 14, 1912. The report states that 169 bags of wolfram were produced in connection with the tin workings during the fiscal year 1911–12. The figure (about 8 long tons) given is an estimate based upon the supposition that the bags probably hold about 100 pounds each.

[h] Statistik des Bergbaues in Österreich, 1912. Wien, pt. 1, pp. 101–103, 1913. From Teplitz and Elbogen, 659.34 metric zentners of wolframite. Percentage of WO_3 in ore unknown.

[i] Mines and quarries: General report, with statistics for 1913, pt. 1, p. 10, district statistics: Home office London, 1914. The quantity is given as 182 (long) tons. The percentage of WO_3, contained is not given. Wolframite.

[j] Ministère des travaux publics. Statistique de l'industrie minérale pour l'année 1911, p. 34, and pour l'année 1912, pp. 34 and 111. The figures as given are: For 1911, 146 tonnes; for 1912, 193 tonnes, containing 137 tonnes of "metal." It seems probable that WO_3 is meant and it has been so interpreted.

[k] Mining Journal, London, vol. 104, p. 129, Feb. 7, 1914. Wolframite, 101 metric tons. Percentage of WO_3 not given.

[l] Figures received from Snr. E. A. Ivo de Carvalho, Eng. das Minas, Lisbon, under date of Aug. 12, 1913. The figures as given are: Wolframite, in 1911, 902.5 toneladas, and in 1912, 1,227.473 toneladas, carrying 65 per cent WO_3.

[m] Revista Minera, Madrid, ano 65, p. 197, 1914. Figures given as 169 metric tons. Supposed to be about 65 per cent WO_3.

[n] Spain in 1913: Min. Jour., Jan. 3, 1914, p. 4. Figures given as 150 (metric ?) tons. See note *q*.

[o] Mines statement: New Zealand Mines Dept., Wellington, 1913, p. XIV. The figures given are for the exports during the year 1911, 135 long tons of scheelite. The output is reduced to a 60 per cent basis on the assumption that it carried 72 per cent WO_3.

[p] Notes from the annual report of the department of mines of Nova Scotia. Year ended Sept. 30, 1912. Canadian Min. Jour., Toronto, vol. 34, p. 189. 14 tons scheelite, 72 per cent WO_3.

[q] El comercio exterior argentino, No. 156, ano 1912. Direccion general de estadistica de la Nacion (Buenos Aires, 1913), p. 204. Figures as given are: "Wolframio, 637,170 kilos, val. $63,717" (Argentine dollar). The percentage of WO_3 is not known. Wolframite.

[r] From figures furnished by Franklin D. Adams of the Pan American Bureau. The figures as obtained were 536 tons (metric), valued at 53,570 pesos (peso 97 cents). The ore is thought to carry about 63 per cent WO_3.

[s] Jiménez, C. P., Estadística minera en 1912: Cuerpo Ing. Minas Bol. 80, pp. 74–78, Lima, 1914. The figures as given are 195 metric tons, carrying 64 to 68 per cent WO_3 (131,070 kilograms WO_3), hübnerite and wolframite.

RADIUM, URANIUM, AND VANADIUM.

By Frank L. Hess.

The production of carnotite-bearing ores during 1913 was the largest to date, and amounted to about 2,269 short tons of dry ore, which contained about 81,990 pounds of U_3O_8, equivalent to 34.8 tons (31,560 kilograms) of metallic uranium. Rutherford [1] has estimated that the quantity of radium in equilibrium with uranium is equivalent to about 1 grain of radium to 3,000 kilograms of uranium, and workers in the Bureau of Mines have estimated that the uranium in carnotite is accompanied by about 90 per cent of the radium required for equilibrium. On the supposition that these figures are approximately correct and that 90 per cent of the radium present is recoverable, then the ores produced contained 8.5 grams of recoverable metallic radium, equivalent to 15.9 grams of hydrous radium bromide ($RaBr_2.2H_2O$) valued, at $120,000 a gram of metallic radium, at $1,020,000.

In the United States uranium minerals were produced in commercial quantities during 1913 only in Colorado and southeastern Utah, and the quantity produced in Colorado was much in excess of the Utah output. The great bulk of the uranium mineral was carnotite, but a small tonnage of pitchblende ore was taken from the Belcher and Calhoun mines, near Central City, Gilpin County, Colo. Only a few pounds were sold, and this was apparently for specimens or experimental use. Fifty dry tons of low-grade material, carrying 1.49 per cent uranium oxide (U_3O_8), was shipped from the Kirk mine, which lies adjacent to the Calhoun and Belcher mines. This material had been mined in a previous year and had been picked over for pitchblende several times. It was too lean to ship under ordinary circumstances, but was bought by a French firm for experimental treatment.

A few pounds of uraninite, the crystalline form of pitchblende, were saved in South Carolina as a by-product in feldspar and mica mining. The exact quantity is unknown, but was small—probably less than 100 pounds.

Carnotite, as the word is ordinarily used, includes both true carnotite ($K_2O.2UO_3.V_2O_5.xH_2O$), the hydrous potash uranium vanadate, and tyuyamunite ($CaO.2UO_3.V_2O_5.xH_2O$), the hydrous lime uranium vanadate. A number of vanadium minerals occur with the carnotite, so that in mining for uranium a great deal of vanadium is also obtained. In general the vanadium in the ore amounts to more than twice the uranium content, although in pure carnotite there is approximately $4\frac{2}{3}$ (4.68) times as much uranium as vanadium, or, in terms of the oxides, 3.09 times as much U_3O_8 as V_2O_5. In only two instances, so far as the Geological Survey is informed, was the vanadium in the carnotite ores paid for, the purchase price ordinarily

[1] Rutherford, Ernest, Radioactive substances and their radiations: p. 16, 1913.

covering only the uranium content; and this base was used not because the uranium was wanted, but because it afforded an almost positive index to the quantity of radium present.

At Vanadium (formerly Newmire), San Miguel County, Colo., the Primos Chemical Co. mines a sandstone which is impregnated with the vanadium-bearing mica, roscoelite. An estimate of this output, added to that of the vanadium contained in the carnotite ores, gives an apparent production of 772 tons of V_2O_5 for the year, equivalent to 432 tons of metallic vanadium.

The vanadium in the carnotite ores is saved as a by-product, probably most of it as ferric vanadate, which is sold to manufacturers of ferrovanadium.

In Colorado, no new discoveries of carnotite-bearing territory are known to have been made during the year. The deposits are found from Routt County south to Dolores County, but only in restricted areas have economically valuable carnotite deposits been found. The greatest area is around Paradox Valley, where carnotite was discovered.

In Utah, deposits have been found on the northwestern, southwestern and southern flanks of the La Sal Mountains, and adjoining areas; and on the San Rafael Swell near Greenriver station. During the year deposits were discovered in Canyon Pintado (East Canyon) and adjoining areas a few miles north of Monticello; on Green River, 8 miles south of Greenriver station; along San Rafael River, 18 miles southwest of Greenriver; and on the east and southwest sides of the Henry Mountains. The last-named deposits are about 100 miles from a railroad, and it seems probable that to be profitably worked the ores must be concentrated before shipping.

Of the carnotite ores produced, 1,125 dry tons, carrying 36,022 pounds of U_3O_8 and 3.7 grams of radium, equivalent to 7 grams of hydrous radium bromide, were kept in this country, and 1,134 dry tons, carrying 45,068 pounds of U_3O_8 and 4.8 grams of radium, equivalent to 8.9 grams of hydrous radium bromide, were shipped to Europe.

The Standard Chemical Co., of Pittsburgh, Pa., and the Radium Co. of America, at Sellersville, Pa., endeavored during 1913 to isolate radium salts, and at the end of the year both companies were apparently about ready to produce refined radium salts.[1] Of the two, the Standard Chemical Co. worked on ores from the vicinity of Paradox Valley, Colo., and the Radium Co. of America worked on ores from the San Rafael Swell, Utah.

The value of imports of radium salts, according to figures obtained from the Division of Statistics, Bureau of Foreign and Domestic Commerce, have been as follows:

Value of imports of radium salts, 1911–1913.

1911	$17,302
1912	18,285
1913[a]	16,218

[1] Viol, Charles H., Radium output of Standard Chemical Co.; Eng. and Min. Jour., vol. 98, p. 25, 1914. Dr. Viol states: "The first finished product was obtained in January, 1914, and contained the equivalent of 560 milligrams of pure radium bromide, or about 300 milligrams of radium element."

[a] During the last three months of 1913, the figures included "radium salts and radioactive substitutes." The quantities of salts are not given.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN UTAH IN 1913.

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

The ore mined in Utah aggregated 10,202,566 short tons in 1913, the metal output of which, with a small placer yield, was valued at $44,858,210, an increase of $1,935,908, as compared with 7,770,270 short tons of ore in quantity and $42,922,302 in value in 1912 from deep mines and placers. There were 217 properties, 7 of which were placers, producing ore and bullion, as against 198 lode producers and 9 placers in 1912. The copper production was over half the total value and amounted to $25,024,124, an increase of $2,368,389. Gold production decreased from $4,265,851 in 1912 to $3,565,229, or $700,622, and the value of the silver yield decreased from $8,509,080 to $7,903,240, or was $605,840 less in 1913. An increase in value of the lead output from $6,314,001 in 1912 to $7,309,579 in 1913 added $995,578 to the total value, but the zinc or spelter output, although increasing in quantity, decreased in value in 1913 from $1,177,635 to $1,056,038, or $121,597. The placer production of gold decreased from $5,680 in 1912 to $1,920 in 1913.

A comparison of totals for metals produced in 1912 and 1913, with differences between the two years, follows:

Mine production of gold, silver, copper, lead, and zinc in Utah in 1912 and 1913.

Year.	Number of producers.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1912.....	207	7,770,270	$4,265,851	13,835,903	137,307,485	140,311,135	17,067,177	$42,922,302
1913.....	217	10,202,566	3,565,229	13,084,835	161,445,962	166,126,790	18,857,827	44,858,210
Increase or decrease in 1913...		+2,432,296	−700,622	−751,068	+24,138,477	+25,815,655	+1,790,650	+1,935,908

[a] Includes a small placer production.

The total metal output of Utah from 1865 to 1913, inclusive, given in the following table, shows a gross value of $635,301,832. This total is made from figuring each of the metals at its average commercial price for each calendar year, and includes $79,314,774 in gold, $239,550,056 in silver, $167,168,711 in copper, $143,380,071 in lead, and $5,888,223 in zinc. It is assumed that half the total gross value, or $317,650,917, was paid out in freight and smelting charges, and that the other half was charged to the cost of mining, milling, development work, and to the payment of dividends. The last item, partly estimated, amounted to $111,139,693, paid by 82 known dividend payers.

Quantity of ore sold or treated in Utah, 1865–1913, number of mines producing, and total output of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.[b]	Lead.[b]	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Tons.*	*Tons.*	*Tons.*	
1864			(c)			(d)		
1865			[e]$55,814	[e]450				$56,416
1866			[e]84,755	[e]800				85,826
1867			[e]96,537	[e]812				97,617
1868			[e]165,375	[e]1,600	(g)	(g)		167,497
1869			[e]187,452	[e]1,750				189,771
1870		[h]9,633	[e]300,000	[e,h]473,182	[h]50	4,166		1,449,566
1871			[e]228,692	[e,h]1,709,811	[h]195	5,000		3,196,260
1872			[h]175,711	2,981,521	[h]300	11,785		5,815,552
1873			52,426	3,157,435	438	15,000		5,919,200
1874			[i]281,293	2,904,246	[h]187	20,000		6,433,881
1875			181,765	2,383,809	[h]358	19,000		5,504,401
1876			182,326	4,436,982	[j]473	25,000		8,578,096
1877			358,108	4,359,733	[j]321	24,194		8,372,920
1878			276,874	4,132,313	[j]382	21,627		6,713,068
1879			325,180	3,665,600	[j]129	14,370		5,657,129
1880	[h]80	[k]142,982	165,788	3,663,183	[j]43	15,214		5,918,252
1881			144,331	4,958,345	[j]193	23,973		8,118,848
1882			186,853	5,435,444	303	29,932		9,432,808
1883			140,000	4,388,541	171	33,330		7,977,957
1884	[l]134	[l]149,062	120,000	5,263,157	133	30,432		8,248,590
1885			180,000	5,232,557	63	25,659		7,793,867
1886			216,000	5,030,958	[m]1,204	24,332		7,799,758
1887			220,000	5,414,185	1,250	22,900		7,931,901
1888	[l]148	[l]190,701	290,000	5,414,062	1,065	22,283		7,698,138
1889	[l]115	[l]175,700	500,000	7,000,000	[m]1,030	31,180		9,790,247
1890	[l]146	[l]249,536	680,000	8,000,000	503	34,132		12,308,915
1891	[l]178	[l]299,412	650,000	8,750,000	781	43,360		13,241,409
1892	[l]174	[l]331,213	660,175	8,100,000	1,105	45,553		11,607,709
1893			853,600	7,196,300	567	35,043		9,182,512
1894			868,031	5,891,901	574	23,190		6,219,488
1895			1,373,000	7,468,100	1,092	31,305		8,464,549
1896			1,899,900	8,827,600	1,751	35,578		10,415,565
1897			1,726,100	6,265,600	1,959	40,537		8,874,405
1898			2,285,400	6,485,900	1,875	39,299		9,563,805
1899			3,450,800	7,093,300	4,792	29,987		12,044,601
1900			3,972,200	9,267,600	9,177	48,044		16,992,869
1901			3,690,191	10,760,800	10,058	49,870		17,795,026
1902	95	1,114,785	3,607,686	11,842,015	11,969	53,914		17,126,097
1903	100	1,412,379	[n]4,344,069	[n]12,204,011	[n]16,424	[n]50,371		19,716,847
1904	112	1,716,947	[n]4,189,292	[n]12,049,446	[n]23,209	[n]58,240	[o]166	[o]22,002,722
1905	121	2,181,061	[n]5,140,920	[n]11,036,471	[n]28,649	[n]51,941	[o]3,551	[o]26,046,948
1906	133	2,348,819	[n]5,218,386	[n]11,550,634	[n]28,297	[n]62,671	3,237	31,419,365
1907	179	2,669,696	[n]5,121,646	[n]10,990,076	[n]32,128	[n]57,969	2,726	31,692,911
1908	179	3,658,957	[n]3,701,387	[n]8,451,338	[n]43,422	[n]44,389	730	23,441,280
1909	179	5,122,589	[n]4,206,548	[n]11,717,172	[n]54,474	[n]74,243	4,930	31,380,092
1910	183	6,389,398	[n]4,032,085	[n]10,466,971	[n]63,798	[n]61,662	8,184	32,199,185
1911	208	7,268,530	[n]4,696,998	[n]12,473,787	[n]73,480	[n]68,248	8,920	36,837,457
1912	207	7,770,270	[n]4,265,851	[n]13,835,903	[n]68,654	[n]70,156	8,533	42,922,302
1913	217	10,202,566	[n]3,565,229	[n]13,084,835	[n]80,723	[n]83,063	9,479	44,858,210
Total			79,314,774	315,820,236	[p]567,749	[p]1,612,142	50,456	635,301,832

[a] Director of Mint estimates unless otherwise indicated.

[b] U. S. Geol. Survey Mineral Resources. Output reported by smelters and refiners unless otherwise indicated.

[c] Californians find placer gold at Bingham, and in spring of 1865 gravel washing actively taken up. (See U. S. Geol. Survey Prof. Paper 38, p. 83, 1905.)

[d] Lead was first produced from ore reduced in a furnace built near the Rollins or Lincoln mine, Beaver County, in the fifties by a Mormon named Isaac Grundy. See M. Eissler, Preface to "The Metallurgy of Argentiferous Lead."

[e] Boutwell, J. M., U. S. Geol. Survey Prof. Paper 38, p. 83, 1905, estimated that during opening period of placer mining in Bingham, including 1871, the production of gold amounted to $1,000,000.

[f] In 1864, the August 29 issue of the Daily Union Vedette, Camp Douglas, Utah, records the first lead-silver bullion produced near Stockton, Utah. Sept. 17, 1866. First successful separation of silver from lead. bullion by J. W. Gibson, Stockton, Utah.

[g] Bancroft, H. H., History of Utah, p. 741, records "the first shipment of ore from Utah was a carload of copper ore from Bingham Canyon in June, [1868], shipped to Baltimore." No figures available.

[h] Raymond, R. W., Mineral Resources west of Rocky Mountains 1870–1872. Estimated by V. C. Heikes from shipments of ore and matte reported by Raymond and the railroad statements.

[i] Includes gold in silver bullion shipped from Germania Refinery; probably accumulation from ores of several districts in Utah with Nevada eliminated.

[j] Utah Central Railroad statement, 1872–1880; metal production for years 1876–1881 estimated by V. C. Heikes.

[k] Tenth Mineral Census, United States, vol. 13, pp. 313–316.

[l] Reports of Director of Mint, 1884–1902.

[m] Wells, Fargo & Co. estimates confirmed by smelter totals. Refiners' figures for 1886 are 500,000 pounds; for 1889, 65,467 pounds.

[n] Mine production, U. S. Geol. Survey Mineral Resources, 1903–1913; figures collected from the mines.

[o] Previous figures of the U. S. Geol. Survey are corrected.

[p] For a complete table of copper statistics, according to refiners' figures, of the United States, by States, from 1845 to 1910 reference is made to U. S. Geol. Survey Mineral Resources, 1910, pp. 170–173, 1911, and for lead in Utah from 1877–1912 see same publication for 1912, pp. 339–340, 1913.

In the foregoing table the statistics from 1902 to 1913 are compiled from reports made by producing companies to the United States Geological Survey. Prior to 1902 the statistics for Utah have been compiled from the best sources available—previous volumes of Mineral Resources, reports of the Director of the Mint, and the valuable contributions to the early mining industry of R. W. Raymond [1]—and, although they are not comparable with the later statistics in accuracy, they are believed to represent approximately the output.

The metallic output and dividends paid by known dividend payers in seven mining regions and districts of Utah from 1866 to 1913, inclusive, are given in the table following:

Principal regions in Utah producing during 1866–1913, with total value of output and dividends.

Region.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.[a]	Dividends.	Number of known dividend payers.
	Value.	*Fine ounces.*	*Tons.*	*Tons.*	*Tons.*		*Value.*	
Piute County	$3,103,440	560,557	(b)	(b)	.....	$3,663,997	$439,561	1
Beaver County	646,848	19,912,696	20,396	191,103	7,634	43,073,986	7,532,704	3
Camp Floyd	19,028,560	[c] 48,760	.....	.....	.....	19,086,072	3,881,323	4
Park City	3,959,132	122,752,048	12,313	551,911	22,454	149,132,118	38,753,126	8
Tintic	28,962,370	105,561,425	72,311	304,250	3,653	148,366,221	27,551,090	28
Bingham (West Mountain)	21,927,883	36,522,898	446,043	371,047	7,535	214,751,781	28,617,046	8
Washington County	.....	7,195,736	5,338	(d)	.....	9,298,281	[c] 900,000	14
Undistributed [f]	1,686,541	23,266,116	11,348	193,831	9,080	47,929,046	3,464,843	16
Total	79,314,774	315,820,236	567,749	1,612,142	50,356	635,301,832	111,139,693	82

[a] Commercial values used for metals produced in each calendar year.

[b] Between 1904 and 1911 the production was 44,244 pounds of copper and 134,361 pounds of lead as reported by producers. Prior to this period no record of production was found.

[c] The yearly production of silver, between 1871 and 1881, was estimated to be 46,000 ounces. (See U. S. Geol. Survey 16th Ann. Rept., pt. 2, p. 355, 1894–1895.) Since that period the gold ores mined carried very little silver, and only 2,760 ounces were reported by producers whose ores yielded a total of 920,741.10 ounces of gold from 1890 to 1913, inclusive.

[d] No records were preserved by producers of occasional lots of lead ore shipped from the Black Warrior and Dixie mines in the Tutsagubet district.

[e] Dividends paid by operators in the Silver Reef section are known to be incomplete. A fair estimate is given by competent authorities.

[f] All other regions and districts, chiefly Little and Big Cottonwood, Ophir, Rush Valley, American Fork, North Tintic, Lucin, and Mount Nebo are included under undistributed.

ORE PRODUCTION IN 1913.

From the mines of Utah, 10,202,566 short tons were produced in 1913, with metal output valued at $44,858,210, an increase of 2,432,296 tons in quantity and of $1,935,908 in value, when compared with the production of 1912. The average total recoverable value per ton was $4.39 in 1913, against $5.52 in 1912, and the gold and silver value declined from $1.64 to $1.12 per ton. Included in the tonnage total is a large quantity of old mine dump material mined in the early years and originating principally in the Tintic district. The quantity of old slag shipped to the smelters from Beaver County was also large, but is now about exhausted. The output of dry or siliceous ores decreased from 369,736 short tons in 1912 to 238,901 tons in 1913. Under this classification is included 68,408 tons of low-grade siliceous gold ores averaging per ton $3.62 in gold and 0.13 ounce of silver.

[1] Raymond, R. W., Mineral resources west of the Rocky Mountains, 1869–1875.

Gold and silver mixed ores, dry or siliceous in character, aggregated 82,165 tons and averaged per ton $4.13 in gold, 10.19 ounces of silver, 16.09 pounds of copper, and 5.92 pounds of lead. The siliceous silver ores in 1913 aggregated 73,294 tons, mined by 21 producers, and averaged per ton $1.18 in gold, 16.06 ounces of silver, 1.77 pounds of copper, and 7.90 pounds of lead, as against 81,234 tons produced by 18 producers in 1912 whose ore averaged $3.91 in gold, 27.06 ounces of silver, 2.5 pounds of copper, and 0.019 pound of lead. As in 1912, the silver ores came principally from the Tintic district, with smaller quantities from Ophir, Rush Valley, and Park City districts. Oxidized iron-manganese ores are produced depending chiefly on the demand of the smelting companies which use it for flux. This ore carried very small quantities of gold and silver in 1913 and was produced in the Tintic and Lucin districts. The total yield increased from 8,053 tons in 1912 to 15,034 tons in 1913. The copper ore mined by 48 producers aggregated 9,070,740 tons and contained 22 cents in gold, 0.26 ounce of silver, 16.77 pounds of copper, and averaged $2.98 per ton in value. In 1913 over 90 per cent of the copper ore, or 8,406,816 tons, was from low-grade porphyry deposits at Bingham and Newhouse. All of the "porphyry" copper ore was concentrated and the concentrates were smelted. The remainder of the copper ore mined was directly smelted and aggregated 662,892 tons. Of this, 494,090 tons were sulphides of copper and iron, averaging $1.65 in gold, 1.5 ounces of silver, and 34.4 pounds of copper, and $7.87 in total value, per ton. The quantity of ore of this character was 69,007 tons greater than the production in 1912. The oxidized copper ores, including ores with an excess of iron, also increased, but the grade was lower. These ores were shipped to smelters and aggregated 168,802 tons, yielding $3.72 in gold, 7.39 ounces of silver, 52 pounds of copper, and averaging $16.34, per ton. The output of lead ores of smelting grade increased from 252,888 tons in 1912 to 357,196 tons in 1913. In this kind of ore smelted the sulphides predominated and increased in quantity in 1913, aggregating 209,881 tons, and averaging $1.03 in gold, 8.93 ounces of silver, 14.4 pounds of copper, 303.8 pounds of lead, and $22.09 in total value, per ton. The oxidized ores of lead, largely carbonates, and some oxidized iron ores, aggregated 147,315 tons, and averaged $2.68 in gold, 29.64 ounces of silver, 10.4 pounds of copper, 294 pounds of lead, and $35.17 in value, per ton. Production of zinc ores of shipping grade increased from 9,422 tons mined in 1912 to 15,300 tons in 1913. The mixed carbonate and siliceous zinc ores were produced in the largest quantities, aggregating 8,020 tons, with a recoverable average of 576.4 pounds of spelter per ton. The zinc sulphide ores aggregated 7,280 tons, averaging a recovery of 1.86 ounces of silver, 119.8 pounds of lead, and 658.4 pounds of spelter, per ton. Production of copper-lead ores decreased from 5,102 tons in 1912 to 2,740 tons in 1913. The oxidized or carbonate copper-lead ores shipped directly predominated and aggregated 1,819 tons, averaging 37 cents in gold, 43.78 ounces of silver, 89 pounds of copper, 406.6 pounds of lead, and $58.51 in value, per ton. The sulphide copper-lead ores aggregated 921 tons and averaged 82 cents in gold, 26.49 ounces of silver, 90.4 pounds of copper, 184.2 pounds of lead, and $38.85 in value, per ton. Lead-zinc ore mined in 1913 aggregated 211,609 tons, against 216,764 tons mined in 1912. All of the lead-zinc ore was milled, producing concentrate, with the exception of

569 tons of carbonate ore, which was reported to have been used in the manufacture of zinc pigment. The average recovery assay of the ore was 249 pounds of lead and 539.6 pounds of zinc per ton. Concentrates recovered from ores at milling plants in 1913 contained 22.3 per cent of the gold, against 21.4 per cent in 1912; 20.1 per cent of the silver, or the same as in 1912; 80 per cent of the copper, against 76 per cent; 31.9 per cent of the lead, against 33 per cent; and 48.4 per cent of the zinc, against 63 per cent in 1912. In 1913 the recoverable metal content of the concentrates was valued at $25,274,244, or an average value of $48.06 per ton, as against a total value in 1912 of $22,781,896 and an average value of $59.74 per ton. Crude ore shipped directly to the smelters yielded 69.8 per cent of the gold in 1913, as against 67.3 per cent in 1912; 77.3 per cent of the silver, as against 78 per cent; 19.8 per cent of the copper, as against 23 per cent; 66.3 per cent of the lead, as against 63 per cent; and 51.5 per cent of the zinc, as against 37 per cent in 1912. In 1913 the total value of the crude ore shipped to smelters was $18,949,742, or an average value of $16.25 per ton, as against a total value in 1912 of $19,188,571, or an average value of $18.51 per ton. At mills using cyanidation and amalgamation in the treatment of ores and tailings, 7.61 per cent of the total gold and 0.47 per cent of the silver was recovered from ores and old tailings valued at $308,024, or an average of $3.88 per ton. In 1912 ores given similar treatment totaled $479,721 in value, or an average of $2.80 per ton.

Output of ore and production of metals in Utah in 1913, by kinds of ore.

Source of production.	Number of producers.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
			Value.	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	7		$1,920	13			
Dry or siliceous	47	[a] 238,901	678,657	2,027,542	1,466,398	1,083,039	
Copper	48	9,070,740	2,069,114	2,314,348	152,137,467	167,227	94,564
Lead	127	662,200	707,262	7,537,361	6,627,953	138,075,527	34,222
Zinc	22	16,322		14,476		871,435	9,539,053
Copper-lead	16	2,794	1,459	105,286	254,773	926,422	
Lead-zinc	27	211,609	106,817	1,085,809	959,371	25,003,140	9,189,988
Total		10,202,566	3,565,229	13,084,835	161,445,962	166,126,790	18,857,827

[a] Includes 15,034 tons of iron ore for flux.

Subdivision of tonnage, by kinds, of ore sold or treated from Utah in 1913, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	1,103	117,282	36,697	7,317	7	5,752	168,158
Box Elder	2,562	4,115	41				6,718
Grand	18						18
Iron	2						2
Juab	129,294	147,289	105,909	1,098	43	344	383,977
Millard			12				12
Morgan			52				52
Piute	11,718	71	20				11,809
Salt Lake	7,703	8,801,879	304,740		940	80,362	9,195,624
Summit	30,104		109,386	1,022		75,781	216,293
Tooele	56,378	104	87,279	1,704	1,804	214	147,483
Utah	19		12,773	5,181		213	18,186
Wasatch			5,291			48,943	54,234
Total	238,901	9,070,740	662,200	16,322	2,794	211,609	10,202,566
Value per ton in gold and silver	$7.97	$0.38	$7.94	$0.53	$23.28	$3.60	$1.12

GOLD.

The recoverable gold content of the ore production was valued at $3,565,229, a decrease of $700,622, compared with 1912. Salt Lake County is credited with the largest production of gold, amounting to $1,777,214, against $1,788,730 in 1912, when it was preceded in output by Juab County, whose production in 1913 amounted to $1,385,070, against $1,804,842 in 1912. Nearly 40 per cent of the total is the yield of the Tintic district, lying in Juab and Utah counties. The largest part of the gold output, or $1,774,815, came from the Bingham district in Salt Lake County. The production of the district was $1,785,532 in 1912. Tooele County has the record for the largest production of gold in Utah for 24 years, from siliceous and some base ores treated by cyanidation; but in 1913 the Mercur mine, producing most of this ore, was abandoned and the mill was dismantled and sold. Placer gold was produced in Garfield, Grand, San Juan, and Uinta counties, and amounted in value to $1,920, against $5,680 in 1912. Milling of the ores in 1913 by amalgamation was carried on in Beaver, Box Elder, and Grand counties, and by cyanidation in Juab, Piute, Salt Lake, and Tooele counties. From these two methods of treatment $271,161 in gold was produced from 75,972 tons of ore and 7,125 tons of old tailings, the latter from an old concentration mill dump in the Tintic district. The total average gold recovery from ore and tailings was $3.88per ton. The gold extracted by amalgamation averaged $6.45 per ton of ore treated, as against $5.20 per ton treated in 1912; and by cyanidation $3.52 per ton treated, as against $2.56 in 1912. From copper, lead, zinc, and copper-lead concentrates, 38,555.29 ounces of gold were produced, against 44,055.07 ounces in 1912. The largest output of gold, or 29,699.38 ounces, was from copper concentrates, against 36,882.93 ounces in 1912; the lead concentrate produced 8,606.73 ounces, against 6,917.15 ounces in 1912; and the zinc concentrates, 193.66 ounces, against 253.92 ounces in 1912. No copper-lead concentrates were produced in 1913.

Source of gold production of Utah, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead. ore.	Lead-zinc ore.	Total.
Beaver	.....	144.18	382.10	508.27	0.27	83.03	1,117.85
Box Elder	.....	251.22	.....	2.56	.....	.....	253.78
Garfield	41.12	.....	.....	.....	.....	.....	41.12
Grand	6.68	18.62	.....	.....	.....	.....	25.30
Iron	.....	.82	.....	.....	.....	.....	.82
Juab	.....	19,533.64	30,894.36	16,569.88	3.48	1.40	67,002.76
Morgan	.....	.....	.....	.29	.....	.....	.29
Piute	.....	2,478.92	23.95	2.03	.....	.....	2,504.90
Salt Lake	.....	1,308.93	68,792.69	11,529.04	36.59	4,305.48	85,972.73
San Juan	25.01	.....	.....	.....	.....	.....	25.01
Summit	.....	99.55	.....	3,158.66	.....	333.25	3,591.46
Tooele	.....	8,974.50	.29	798.36	30.24	.48	9,803.87
Uinta	20.07	.....	.....	.....	.....	.....	20.07
Utah	.....	19.65	.....	1,458.55	.....	.24	1,478.44
Wasatch	.....	.....	.....	186.16	.....	443.39	629.55
Total	92.88	32,830.03	100,093.39	34,213.80	70.58	5,167.27	172,467.95

SILVER.

The recoverable silver content of the ore production of Utah in 1913 was 13,084,835 ounces, valued at $7,903,240, and showed a decrease of 751,068 ounces in quantity and of $605,840 in value. Juab County was again in the lead with 5,600,617 ounces, against 6,638,425 ounces in 1912, but Utah County only produced 265,850 ounces in 1913, against 531,478 ounces in 1912. The Tintic district, covering parts of these two counties, decreased its output from 7,073,104 ounces in 1912 to 5,829,484 ounces in 1913. Summit and Wasatch counties, embracing the Park City district, produced 3,717,556 ounces in 1913, an increase of 74,807 ounces over the output of 1912. Salt Lake County produced 2,504,021 in 1913, against 2,218,822 ounces in 1912. The Bingham district contributed the largest part, or 2,408,692 ounces in 1913 and 2,028,496 ounces in 1912. Concentrates produced at milling plants yielded 2,637,873 ounces of silver, against 2,785,154 ounces in 1912. The copper ores milled produced 324,586 ounces from concentrates in 1913, against 347,867 ounces in 1912 and 431,405 ounces in 1911. Lead concentrates from low-grade lead ore contained 2,177,101 ounces, or an average of 16.82 ounces per ton, against 2,247,050 ounces of silver, or an average of 21.61 ounces per ton in 1912; zinc concentrates contained 9.76 ounces per ton, against 11.69 ounces per ton in 1912. Silver in bullion produced from ores and tailings treated by amalgamation aggregated 312 ounces, against 46 ounces in 1912, and that by cyanidation was 60,720 ounces, against 64,422 ounces in 1912. The output of silver from a new method of treating Ontario low-grade ore at Park City resulted in the shipment of a silver product, which is expected to increase through the operation of the American Flag mill (formerly Grasselli dry concentrator) at Park City and the Knight-Christensen mill at Silver City.

Source of silver production in Utah, by kinds of ore, in 1913, by counties in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	.....	4,945	35,009	270,952	13,576	62	19,893	344,437
Boxelder	.....	51	779	375	.....	.....	.....	1,205
Garfield	7	.....	.....	.....	.....	.....	.....	7
Grand	2	2	.....	.....	.....	.....	.....	4
Iron	.....	1,037	.....	.....	.....	.....	.....	1,037
Juab	.....	1,695,484	1,225,677	2,677,549	.....	1,400	507	5,600,617
Millard	.....	.....	.....	12	.....	.....	.....	12
Morgan	.....	.....	.....	97	.....	.....	.....	97
Piute	.....	7,860	1,635	244	.....	.....	.....	9,739
Salt Lake	.....	51,350	1,051,062	1,134,516	.....	24,697	242,396	2,504,021
San Juan	2	.....	.....	.....	.....	.....	.....	2
Summit	.....	255,526	.....	2,432,740	900	.....	401,116	3,090,282
Tooele	.....	11,242	186	549,579	.....	79,127	115	640,249
Uinta	2	.....	.....	.....	.....	.....	.....	2
Utah	.....	45	.....	265,709	.....	.....	96	265,850
Wasatch	.....	.....	.....	205,588	.....	.....	421,686	627,274
Total	13	2,027,542	2,314,348	7,537,361	14,476	105,286	1,085,809	13,084,835

COPPER.

Utah's production of copper in 1913 was 161,445,962 pounds, valued at $25,024,124, an increase of 24,138,477 pounds in quantity and of $2,368,389 in value. The Bingham district produced 144,920,494 pounds of copper in 1913, against 116,621,793 pounds in 1912,

129,995,865 pounds in 1911, and 113,725,280 pounds in 1910. The Tintic district yielded 9,261,867 pounds in 1913, against 13,339,126 pounds in 1912, a decrease of 4,077,259 pounds. The Park City district of Summit and Wasatch counties produced 1,794,170 pounds in 1913, against 1,968,249 pounds in 1912; and Beaver County, 3,137,234 pounds in 1913, against 3,040,400 pounds in 1912. All concentrates recovered at milling plants in Utah contained 129,253,116 pounds of copper, against 104,999,753 pounds in 1912. Copper concentrates contained 126,364,491 pounds in 1913, against 102,539,091 pounds in 1912; lead concentrates contained 2,820,409 pounds of copper, against 2,315,119 pounds in 1912; and zinc concentrates contained 68,216 pounds, against 85,376 pounds. Copper-lead concentrates were produced in 1912, but none in 1913. Crude ore shipped to smelters contained 31,994,380 pounds of copper, against 31,678,257 pounds in 1912. The crude copper ores smelted contained 25,719,652 pounds, of which 16,953,098 pounds were produced from sulphide ores and 8,766,554 pounds from oxidized ores. Lead ores yielded 4,582,358 pounds of copper, the sulphide ores producing 3,038,868 pounds and oxidized ores 1,543,490 pounds. Copper-lead ores contained 245,193 pounds of copper, of which the oxidized ores contained 161,943 pounds and the sulphide ores 83,250 pounds. From the low-grade copper-bearing porphyries at Bingham and Newhouse there were produced 126,364,491 pounds of copper, against 102,662,335 pounds in 1912 and 106,062,937 pounds in 1911.

Source of copper production of Utah, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	4,254	2,881,221	244,271	1,122	6,356	3,137,234
Boxelder	12,852	609,138	216	.....	.....	622,206
Iron	22	.....	.....	.....	.....	22
Juab	1,399,796	7,194,526	696,292	2,802	245	9,293,661
Millard	.....	.....	36	.....	.....	36
Piute	467	3,437	.....	.....	.....	3,904
Salt Lake	14,751	141,414,081	3,052,083	88,940	495,333	145,065,188
Summit	34,066	.....	1,110,800	.....	198,980	1,343,846
Tooele	190	35,054	1,325,367	161,909	76	1,522,596
Utah	.....	.....	6,945	.....	.....	6,945
Wasatch	.....	.....	191,943	.....	258,381	450,324
Total	1,466,398	152,137,467	6,627,953	254,773	959,371	161,445,962

LEAD.

The lead production of Utah in 1913 was 166,126,790 pounds, valued at $7,309,579, against 140,311,135 pounds, valued at $6,314,001, in 1912. The Bingham or West Mountain district had the largest production, 71,001,138 pounds, or about 43 per cent of the total, against 43,822,495 pounds in 1912. This increase was due to the greatly enlarged tonnage of lead sulphide ore shipped by the Utah Apex and from the copper mines of the Bingham-New Haven and Utah Consolidated Cos. The Park City district produced 41,808,713 pounds of lead in 1913, or a fourth of the total output, against 42,111,561 pounds, the yield of 1912. The Tintic district produced 26,279,312 pounds, against 24,356,041 pounds in 1912. The combined production of Ophir and Rush Valley districts, in Tooele County, aggregated 14,054,788 pounds, against 17,250,388 pounds in

1912. An increase was recorded in the Beaver County production of lead from 7,652,669 pounds in 1912 to 10,454,583 pounds in 1913. Concentrates, mostly sulphides, from the milling plants in the State, shipped to the smelters, contained 53,140,609 pounds of lead, against 46,532,086 pounds in 1912, averaging 20.23 per cent in 1913 and 21.88 per cent in 1912 of lead in lead concentrates; zinc concentrates contained 791,513 pounds, averaging 2.87 per cent of lead in 1913 and 3.13 per cent in 1912. The total crude ore of shipping grade contained 110,168,122 pounds of lead, against 88,710,465 pounds in 1912. Sulphide lead ore predominated and yielded 63,765,938 pounds of lead, against 49,346,148 pounds in 1912. The oxidized lead ores yielded 43,312,981 pounds of lead, against 33,728,628 pounds in 1912. Zinc ores contained 871,435 pounds, all of which was reported in sulphide ores. Copper-lead ores contained 909,499 pounds, of which the oxidized and carbonate ores produced 739,777 pounds and the sulphides 169,722 pounds. The lead-zinc ores, all oxidized or siliceous in character, contained 141,670 pounds of lead.

Source of lead production of Utah, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	4,816	.....	8,423,116	871,435	1,473	1,153,743	10,454,583
Box Elder	.....	.....	15,832	.....	.....	.....	15,832
Juab	851,778	146,925	21,396,510	.....	15,665	97,561	22,508,439
Millard	.....	.....	6,193	.....	.....	.....	6,193
Morgan	.....	.....	23,994	.....	.....	.....	23,994
Piute	41,398	.....	5,060	.....	.....	.....	46,458
Salt Lake	17,575	20,302	61,495,162	.....	174,020	10,403,966	72,111,025
Summit	161,062	.....	26,181,831	.....	.....	6,274,507	32,617,400
Tooele	6,410	.....	13,826,685	.....	735,264	51,507	14,619,866
Utah	.....	.....	4,486,700	.....	.....	44,987	4,531,687
Wasatch	.....	.....	2,214,444	.....	.....	6,976,869	9,191,313
Total	1,083,039	167,227	138,075,527	871,435	926,422	25,003,140	166,126,790

ZINC.

The zinc ores of Utah yielded 18,857,827 pounds of recoverable zinc valued at $1,056,038 in 1913, against 17,067,177 pounds in 1912. The ores of Beaver County, principally from the Horn Silver mine, yielded 5,522,324 pounds, against 1,176,186 pounds in 1912, and the Park City region, the next in production, followed with 4,980,206 pounds, against 8,001,512 pounds in 1912. The Tintic district, which became an important producer in 1912, decreased slightly, from 3,709,737 pounds in 1912 to 3,596,544 pounds in 1913. The Bingham district increased its output from 2,711,982 pounds in 1912 to 3,421,724 pounds in 1913. The Ophir and North Tintic districts in Tooele County produced 1,186,065 pounds, against 1,234,092 pounds in 1912. Zinc concentrates, aggregating 13,802 tons, containing 9,134,638 pounds, were produced in Salt Lake, Wasatch, Summit, Beaver, Tooele, Juab, and Utah counties. Crude zinc ore shipped directly to smelters contained 9,723,189 pounds in 1913, as against 5,596,442 pounds in 1912. The oxidized zinc ores predominated and 8,020 tons yielded 4,623,027 pounds of zinc; the sulphide ores, of which there were 7,280 tons, contained 4,793,130 pounds. The latter came principally from Beaver County, and the oxidized zinc ores were produced in the Tintic district of Juab and Utah counties and in the North Tintic district of Tooele County.

Source of zinc (spelter) production of Utah, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Beaver			4,818,392	703,932	5,522,324
Juab			628,303	132,909	761,212
Salt Lake	94,564	25,203		3,301,957	3,421,724
Summit			122,896	2,336,887	2,459,783
Tooele		9,019	1,091,818	101,731	1,202,568
Utah			2,877,644	92,149	2,969,793
Wasatch				2,520,423	2,520,423
Total	94,564	34,222	9,539,053	9,189,988	18,857,827

Zinc ore and concentrates produced from Utah mines and mills, sold in 1913, and source, by counties.

County.	Classification.	Quantity.	Average assay of ore or concentrates.[a]
		Short tons dry weight.	*Per cent.*
Beaver	Sulphide ore	7,280	38.23
Beaver, Juab, Tooele, and Utah	Mixed carbonate and silicate ore	8,589	33.68
Beaver, Juab, Salt Lake, Summit, Tooele, Utah, and Wasatch.	Concentrates and middlings	13,802	38.93
Total	Ore, concentrates, and middlings	29,671	37.35

[a] Actual zinc content.

METAL-MINING INDUSTRY IN UTAH IN 1913.

Utah was free from labor troubles in 1913, and in consequence its metal production reached a new high record for lead, copper, and zinc. The silver output was slightly less than in 1912, and the gold production also declined, owing to the closing of the Mercur mine, the largest single gold producer, which had been active for 24 years. At no time in the history of Utah has so great a quantity of ore been handled as at Bingham in 1913. There were four methods of transportation out of the camp—by the two railway lines, the Denver & Rio Grande and the Bingham & Garfield; by the tramway of the Utah Consolidated, over which was hauled its own ores, and that of the Bingham-New Haven mine to the International smelter; and by the Bingham Central Railway, which operates through the 3-mile Mascotte tunnel and hauls ores of the Ohio Copper Co. Mining companies owning properties in Utah disbursed dividends aggregating $5,677,129 in 1913, against $5,184,738 in 1912. Both of these totals eliminate from the Utah Copper Co. dividend the amount paid by the Nevada holdings of that company, and an estimate is included for the approximate dividend of the United States Mining Co in Utah. Electrical machinery is used by an increasing number of Utah mines. The smaller companies are replacing steam-driven hoists and compressors with more effective and less cumbersome electrical machinery, and at the larger properties constant improvements in power arrangements are being made. The Salt Lake & Alta Railroad was completed between Sandy and Wasatch in the Little Cottonwood Canyon in November. It is a standard-gauge line and will reduce the wagon haul for Alta ores 9 miles from the western end of the Michigan-Utah tramway to the smelters.

METALLURGICAL INDUSTRY.

Only 4 smelting plants out of 9 in Utah operated in 1913. They were the Garfield and Murray plants of the American Smelting & Refining Co., the Midvale plant of the United States Smelting & Refining Co., and the International plant near Tooele of the International Smelting & Refining Co. There were no big additions made to the plants, but a large amount of work was done in improving methods. At the Garfield plant two oil storage tanks of 40,000 gallons capacity were erected, and 4 of 6 reverberatory furnaces are using oil. At present a 350-foot stack is being completed, the tallest in the State, for the purpose of carrying out experiments with the Cottrell method of fume treatment and at the same time saving some of the values usually lost in dust and fumes. At the Murray plant three Wedge furnaces and one Dwight-Lloyd sintering machine have been added to the roasting equipment. On December 16 experiments were carried on for the first time in the treatment of gases from lead furnaces by the Cottrell method, and, although through the use of an extensive bag house the smelter fumes have been controlled, the success of the new method would add greatly to the present efficiency. The Midvale smelter made several slight changes to increase the efficiency of its plant. It is better able to control its fumes than some of the other plants by a patented process whereby the gases are neutralized and the solids are precipitated. Through the use of its bag house and flues, considerable arsenic is saved and returns a profit each year. The lead furnaces of the company treat about 800 tons of ore per day, or from 975 to 1,000 tons of charge per 24 hours. The lead ores have been about equally divided between custom work and material from the company's own mines. The Huff electrostatic separating plant, with which the Midvale smelter is equipped, and the wet concentration mill handle the company's zinc ores from Bingham and also considerable custom ore. The International plant has lead and copper furnaces for the treatment of both classes of ore, of which large additions were made to the stock pile. Another furnace was added to its lead plant, making five furnaces now in use. An average of about 1,000 tons of lead ore per day is handled. A bag house containing 1,100 bags is profitably operated. Five copper furnaces were built when the plant was first constructed in 1908 and were started on December 8 of that year. Much siliceous ore has been treated in these furnaces, which resumed early in 1913 the treatment of copper ores and little trouble was found in treating the leady matte from the lead plant along with the copper matte from the reverberatories. Ten Dwight-Lloyd machines were brought up to capacity in the sintering plant.

The principal equipment [1] of the smelting plants near Salt Lake City is as follows:

UNITED STATES SMELTING COMPANY.

[Lead and copper smelting works at Midvale, Utah.]

Sampling mill.

1 20 by 10 inch Blake crusher.
1 42-inch Snyder sampler, 1/5 cut.
2 14-inch bucket elevators.

[1] Eng. and Min. Jour., Aug. 8. 1914, pp. 244–247.

1 No. 2 Gates crusher, style D.
1 42-inch Snyder sampler, 1/6 cut.
1 14 by 27 inch Davis rolls.
1 27-inch Snyder sampler, 1/6 cut.
1 14 by 26 inch Colorado Iron Works rolls.
1 27-inch Snyder sampler, 1/6 cut.
1 50-horsepower General Electric motor.

Sulphide sampling mills.

1 20 by 10 inch Blake crusher.
2 14-inch bucket elevators.
2 16 by 36 inch Allis-Chalmers rolls.
1 27-inch Snyder sampler, 1/10 cut.
2 27-inch Snyder samplers, 1/6 cut.
1 50-horsepower General Electric motor.

Converter roasting department.

1 18-cubic-foot Smith concrete mixer.
1 14-inch bucket elevator.
19 6 by 6 by 4 foot box roasters.
1 6 by 6 by 4 foot box roaster (priming furnace).
1 24 by 36 inch Farrel crusher.
1 76-cubic-foot skip hoist.
1 20-ton Whiting crane.
1 Ram car.
1 American blower.
1 100-horsepower General Electric motor.

Mechanical roasting department.

2 21-foot 6-inch 7-hearth Wedge furnaces.
2 21-foot 6-inch 7-hearth Wedge furnaces (under construction).
1 16-inch belt conveyor.
2 16-inch belt feed conveyors.
1 link-belt pan conveyor.
1 8-foot 6-inch balloon flue.

Dwight-Lloyd sintering plant.

1 16-inch belt conveyor.
4 42 by 264 inch straight-line sintering machines.
1 5-foot 6-inch balloon flue.
1 3-hearth ZnO neutralizing furnace.

Lead blast-furnace department.

6 48 by 160 inch blast furnace.
3 140-cubic-foot charge cars, 6-foot gage.
3 130-cubic-foot charge-weighing larries, 6 tons capacity.
4 10-ton electric locomotives.
20 28-cubic-foot Stearns-Rogers slag pots.
3 Remelting kettles.
3 12-inch and 24 by 36 inch Nordberg Corliss tandem engines, each connected to—
3 175-cubic-foot Connersville blower.

Bag house.

1 122-inch American fan, Wedge furnace and Dwight-Lloyd flues.
1 13-foot 6-inch Sturtevant fan, roaster gases.
1 15-foot Sturtevant fan, blast-furnace gases.
1 50-horsepower motor, 122-inch fan.
2 100-horsepower motor, 13-foot 6-inch and 15-foot fans.
1,462 18-inch by 30-foot woolen bags, blast furnace gases.
1,878 18-inch by 30-foot woolen bags, roaster gases.
21 9-inch screw conveyors and dust hoppers.

Arsenic plant.

2 14½-foot Brunton revolving-hearth furnaces.
2 Crude-arsenic chambers, 16 by 200 feet, one section in operation.
1 Steel-plate fan.
36 18-inch by 25-foot woolen bags, 18 on each chamber.
1 10-horsepower motor.
1 10 by 20 foot reverberatory refining furnace.
1 refined arsenic chamber, 10 by 175 feet.
1 steel-plate fan.
18 18-inch by 25-foot woolen bags.
1 5-horsepower motor.

Copper blast-furnace department.

[Inoperative.]

6 46 by 186 inch blast furnaces.
1 17 by 58 foot reverberatory furnace.
5 84 by 126 inch copper converters.
1 20-inch, 36-inch, and 44 by 48 inch Allis-Chalmers converter blowing engines.
1 20-inch, 42-inch, and 44 by 48 inch Nordberg cross-compound condensing engine.
3 15-inch, 30-inch, and 63 by 42 inch Allis-Chalmers blowing engines, blast-furnace air.
2 14-inch and 28 by 36 inch Nordberg cross-compound condensing engines, each connected to—
2 300-cubic foot Roots blowers.

Stacks.

1 245 by 16½ foot steel stack, brick lined, lead plant.
3 100 by 6½ foot steel stacks, bag house.
1 210 by 16½ foot steel stack, brick lined, copper plant.
1 150 by 7 foot steel stack, reverberatory.
1 200 by 8 foot stack, converters.

Wet concentrator.

1 9 by 15 inch Blake crusher.
4 30 by 12 inch Allis-Chalmers rolls.
7 3-compartment single Harz jigs.
10 Overstrom tables.
17 Wilfley tables.
3 Isbell vanners.
1 Craven slime table.
1 Sherman slime table.
18 slime-settling tanks.
8 3 by 6 foot trommels.
3 3½ by 6 foot trommels.
1 5 by 14 foot Denver Engine Works tube mill.
2 75-horsepower motors.
1 50-horsepower motor.
1 30-horsepower motor.
1 25-horsepower motor.

Electrostatic zinc mill.

1 5 by 30 foot Ruggles-Cole drier.
2 6 by 6 foot Newago screens.
21 Huff electrostatic machines, style D.
1 Huff electrostatic machine, style E.
2 25-horsepower motors.
1 10-horsepower motor.
2 7½-horsepower motors.
1 motor-generator set with rectifier equipment.

INTERNATIONAL SMELTING CO.

[Lead and copper smelting works at International (Tooele post office), Utah.]

Receiving bins, 30 by 300 feet; capacity, 15,000 tons ore, 2,000 tons coal.
6 30-inch belt conveyors and two automatic feeders.

Sampling mill.

8 20-inch belt conveyors to copper plant bins.
2 20-inch belt conveyors to lead plant bins.
2 24 by 12 inch Blake crushers.
6 20 by 10 inch Blake crushers.
8 Brunton oscillating time samplers, 1/5 cut.
4 18-inch bucket elevators.
2 16-inch bucket elevators.
2 54 by 24 inch crushing rolls.
2 42 by 15 inch crushing rolls.
2 48 by 12 inch crushing rolls.
2 26 by 15 inch crushing rolls.
2 4 by 14 foot trommels.
2 4 by 7 foot trommels.
1 12-inch belt man elevator.
1 platform elevator.

Lead-smelting department.

Sintering department.

Building, 42 by 160 feet.
10 42 by 264 inch Dwight-Lloyd sintering machines.
5 motor-driven fans, direct coupled.
10 variable-speed direct-coupled motors, machine drives.
20 rotating sinter-charge apportioning tables and control apparatus.
1 rotating charge mixer.
2 20-inch belt conveyors, sinter charge to mixer.
3 18-inch belt conveyors, sinter charge to sinter-machine feed hoppers.

Blast-furnace department.

2 48 by 180 inch lead blast furnaces.
3 60 by 180 inch lead blast furnaces.
2 16-inch belt dust conveyors.
5 200-cubic foot electric-driven charge cars.
1 12 by 38 foot slag-settling furnace.
6 5-ton slag-pot cars.
12 7-ton slag-pot cars.
4 12-ton electric locomotives.
4 30-ton drossing kettles.
2 bullion-weighing scales.
1 Howard press, compressed-air operated.
2 motor-driven jacket-cooling water pumps.
1 cooling tower, jacket-cooling water.
Steel flue, balloon type, to bag house fan.
Blast-furnace charge bins, 32 compartments arranged with suspended charge-weighing hoppers for all blast-furnace charge materials; railway tracks and belt conveyor to bins.
1 coke-charge bin, 750-ton capacity, arranged with suspended charge-weighing hoppers.
1 30-inch belt conveyor, coke supply to bin.

Bag house.

Building, 56 by 160 feet, 10 sections with burning chambers.
1 No. 20 Sirocco centrifugal fan.
1 100-horsepower motor belted to fan.
1,440 18-inch by 31-foot cotton and woolen bags.
1 No. 4½ Sirocco reversed-current fan for shaking bags.

Copper-smelting department.

Roaster crushed-ore bins, 5,000 tons capacity.
Miscellaneous crushed-ore bins, 3,000 tons capacity.
4 20-inch belt conveyors to roaster plant.
5 20-inch belt conveyors and trippers.
32 16-foot 6-hearth McDougal roasters.
5 19 by 102 foot reverberatory furnaces.
4 750-horsepower Stirling waste-heat boilers.
1 750-horsepower Stirling stoker-fired boilers.
5 8 by 12½-foot barrel-type converters.
1 60-ton Morgan electric crane.
2 25-ton Morgan electric crane, slag return to reverberatory furnaces.
1 350 by 25-foot brick stack.
1 150 by 15-foot brick converter stack.
1 30-ton electric casting crane.

Converter bag house.

960 18-inch by 30-foot woolen bags.
1 No. 20 Sirocco fan, belt driven by
1 100-horsepower motor.
1 No. 4½ Sirocco reversed-current fan and motor.
8 spiral-screw conveyors for fume.
2 16-inch belt conveyors for fume.

Power plant.

2 350-horsepower Corliss-valve engine direct connected to—
2 250-kilowatt direct coupled generators.
1 750-horsepower 11-pound converter blowing engine.
1 600-horsepower 11-pound converter blowing engine.
1 90-pound 350-horsepower steam-driven air compressor.
1 90-pound 175-horsepower electric-driven air compressor.
2 No. 10 Roots blowers, direct coupled to Corliss engines.
3 350-horsepower Stirling water-tube boilers.
3 Le Blanc condensers.
2 1,000-kilovolt-ampere 2,200-volt electric generators, direct coupled to triple-expansion engines.
1 1,000-kilovolt-ampere 2,200-volt electric generator, steam-turbine driven.

AMERICAN SMELTING & REFINING CO.

[Lead smelting works at Murray, Utah.]

4 sampling mills.
3 7-hearth Wedge roasting furnaces, 22 feet 6 inches diameter.
5 Godfrey roasting furnaces, 26 feet diameter.
2 42 by 264 inch Dwight-Lloyd sintering machines.
4 7-foot cast-iron mixing tables, 1½ revolutions per minute.
23 9-foot Huntington-Heberlein pots.
1 20-ton traveling crane.
8 48 by 168 inch blast furnaces.
4 35-ton drossing kettles.
3 sweater kettles.
1 90 by 216 foot bag house.
1 18 by 6 foot fan.
4,032 18-inch by 30-foot raw wool bags.
1 18 by 38 by 42 inch tandem-compound engine, driving—
1 No. 10 Connersville blower.
2 20 by 40 and 68 by 68 inch Dixon cross-compound blowing engines.
2 18 by 36 by 36 inch cross-compound engines, driving—
2 400-kilovolt-ampere generators.
1 80-pound single-stage air compressor.
7 250-horsepower marine boilers.
3 94,000-gallon water-storage tanks.

GARFIELD SMELTING CO. (AMERICAN SMELTERS SECURITIES CO.)

[Copper smelting works at Garfield, Utah.]

Lands, 30,000 acres.
Plant site, several hundred acres.
Standard-gauge track, 16 miles.
Belt-conveyor system, 8,675 feet.
Concentrate bins, 25,000 tons.
Daily consumption of materials: Concentrates, 1,500 tons, representing about 25,000 tons of crude ore; ores, 1,500 tons; lime rock, 800 tons; coke, 200 tons; coal, 30 tons; oil for reverberatories, 1,300 barrels.
Employees, 1,200.

Sampling department.

2 buildings, 83 by 70 by 72 feet.
2 oxide sampling mills.
2 sulphide sampling mills.
Combined daily sampling capacity, 2,400 tons.

Roasting department.

16 6-hearth McDougal roasters, 18 feet diameter.
14 6-hearth McDougal roasters, 19½ feet diameter.
4 7-hearth Herreshoff roasters, 19½ feet diameter.
Total daily capacity, 2,400 tons.

Smelting department.

Main smelting building, 305½ by 840 feet.
4 42 by 240 inch blast furnaces.
4 15 by 25 foot oval settlers (dust chamber is 300 feet long with cross-sectional area of 920 square feet, having wires suspended at intervals of 1⅝ inches and arranged with mechanical shakers).
4 19 by 112 foot reverberatory furnaces.
1 20½ by 112 foot reverberatory furnace.
1 20½ by 120 foot reverberatory furnace.
(Five of these furnaces are oil fired and one is at present being fired with pulverized coal as an experiment.)
12 350-horsepower Stirling waste-heat boilers.
6 10 by 24 foot Peirce-Smith converters.
3 60-ton Shaw electric cranes.
1 25-ton copper pouring ladle.
2 24-foot Walker copper casting wheels.
170 17 by 60 inch converter slag molds, 4 inches deep, mounted on rockers over receiving bins.
24 5-ton charge cars.
5 6-ton General Electric locomotives.
36 10-ton slag cars.
15 10-ton converter slag cars.
4 General Electric locomotives.
6 2-ton "basket" cars.
3 3-ton General Electric locomotives.
15 Atlas larry cars.
1 15-ton Browning locomotive crane.
2 15-ton Bay City locomotive cranes.
2 26-ton American saddle-tank locomotives.
1 45-ton American saddle-tank locomotive.
10 50-ton Ingoldsby standard dump cars.
1 Cottrell fume-condensing chamber, 105 feet long, designed to handle 250,000 cubic feet of gas per minute.
2,520 5-inch pipes, 10 feet long, with a wire through the center charged at 20,000 volts.
1 22 by 350 foot brick stack.

1 30 by 300 foot brick stack.
2,300 feet of brick blast-furnace flue, area 320 square feet.
620 feet of steel blast-furnace flue, area 215 square feet.
600 feet of brick blast-furnace flue, area 360 square feet.
1,600 feet of brick roaster flue, area 320 square feet.
1,200 feet of brick reverberatory flue, area 320 square feet.
775 feet of brick reverberatory flue, area 360 square feet.
900 feet of steel converter flue, area 227 square feet.

Power department.

2 17 by 34 by 36 inch Nordberg cross-compound engines.
1 15 by 30 by 36 inch Nordberg tandem-compound engine.
1 14 by 28 by 36 inch Nordberg tandem-compound engine.
1 15 by 30 by 36 inch Allis tandem-compound engine.
1 15 by 30 by 36 inch Allis cross-compound engine.
3 23 by 50 and 54 by 48 inch Nordberg cross-compound blowing engines.
2 400-kilowatt 250-volt General Electric generators.
1 250-kilowatt 250-volt Westinghouse generator.
1 500-kilowatt Curtis turbo-generator, four-stage, 4,000-volt, 1,800 revolutions per minute.
3 300-cubic-foot Connersville blowers.
1 250-cubic-foot Roots blower.
1 500-cubic-foot Leyner two-stage cross-compound air compressor.
1 1,400-cubic-foot Chicago Pneumatic two-stage cross-compound air compressor.
1 20 by 20 ¼ by 24 inch Sergeant straight-line compressor.
8 350-horsepower Stirling boilers (power-house battery).

Milling plants using amalgamation in the recovery of gold were operated in Beaver, Box Elder, and Grand counties. Cyanidation was used on the siliceous and roasted arsenical ores containing gold at Mercur, and the gold-silver ores in Gold Mountain district of Piute County. In Juab and Salt Lake counties siliceous silver ores and tailings were treated successfully by cyanidation. At Park City the Mines Operating Co., leasing part of the Ontario mine and the mill, treated the low-grade ore by a new method [1] in which chlorination is involved. A great deal of experimental work has been necessary, especially in the mechanical end, and at present the plant is operating successfully on ore that will assay 6 to 14 ounces of silver, 0.01 to 0.015 ounce of gold, 2 to 4 per cent lead, and 1 to 2 pounds of copper, and a saving of 80 per cent is claimed. Figures for the gold, silver, copper, and lead, saved from the Ontario ore by the new method of treatment are included in the total output of the State, but are not given separately in order not to expose individual production. Two other plants using a process similar to the one at Park City are being perfected (May, 1914), one at Silver City and the other near Park City. There were 75,972 tons of ore treated by amalgamation and cyanidation. The treatment of 1,157 tons of ore by the amalgamation process produced 360.80 ounces of gold and 312 ounces of silver. At cyanide mills, 74,815 tons of ore yielded 12,756.63 ounces of gold and 60,720 ounces of silver. This includes bullion extracted from 7,125 tons of old tailings. The total bullion output from gold and silver mills was valued at $308,024, or an average recovery value of $3.88 per ton, against $479,724, the value of the output for 1912, which represented an average recovery of $2.57 per ton.

[1] Described in this report in the review of the Park City region, Summit County.

Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Utah in 1913, by counties.

County.	Quantity.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	
Beaver, Box Elder, and Grand	1,157	360.80	312	.....	.....	$7,646
Juab, Piute, Salt Lake, and Tooele	74,815	.....	.....	12,756.63	60,720	300,378
Total	75,972	360.80	312	[a] 12,756.63	60,720	308,024

[a] 7,125 tons of old tailings from concentration mill in Juab County yielded gold and silver by cyanidation.

Tonnage of ore to gold and silver mills, with average recovery of gold and silver in bullion and cyanide product produced in Utah, 1903–1913.

Year.	Quantity.	Average recovery.		Average value per ton.
		Gold.	Silver.	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	
1903	445,114	$3.93	0.28	$4.08
1904	363,883	3.28	.20	3.40
1905	416,530	3.23	.19	3.35
1906	408,712	3.10	.13	3.19
1907	263,020	3.26	.16	3.37
1908	313,845	3.03	.06	3.06
1909	287,659	2.86	.02	2.87
1910	263,041	2.87	.02	2.88
1911	267,111	2.35	.42	2.57
1912	171,117	2.57	.38	2.80
1913	[a] 75,972	3.57	.80	4.05

[a] Largely from Mercur and Annie Laurie mines.

MINE PRODUCTION IN UTAH IN 1913.

The following tables give the quantity of material shipped from the concentration mills and of crude ore to the smelters, with metal yield by counties in 1913, also the kinds of concentrate and metals contained in each kind, showing the average content covering the period from 1903 to 1913, inclusive:

Mine production of gold, silver, copper, lead, and zinc from Utah concentrates in 1913, by counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc. (Spelter).	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver	104,850	12,669	503.68	34,648	1,911,495	1,153,743	703,932	$417,806
Juab	143	66	1.40	507	245	28,308	9,561	2,153
Piute	20	91	24.57	2,626	467	46,458	.....	4,210
Salt Lake	8,527,755	443,640	36,061.61	806,031	125,616,482	24,623,579	3,421,724	21,977,912
Summit	139,871	26,342	1,262.91	1,050,587	360,827	14,302,431	2,459,783	1,483,645
Tooele	61,700	27,414	257.48	321,153	1,105,029	5,969,148	16,503	634,146
Utah	97	50	.26	635	190	40,073	2,712	2,332
Wasatch	48,943	15,628	443.38	421,686	258,381	6,976,869	2,520,423	752,040
Total	8,883,379	525,900	38,555.29	2,637,873	129,253,116	53,140,609	9,134,638	25,274,244
Subdivision by kinds of concentrates:								
Siliceous	.....	22	55.02	1,424	.....	.....	.....	1,997
Copper	.....	382,663	29,699.88	324,586	126,364,491	.....	.....	20,396,498
Lead	.....	129,413	8,606.73	2,177,101	2,820,409	52,349,096	.....	4,233,410
Zinc	.....	13,802	193.66	134,762	68,216	791,513	9,134,638	642,339

Kinds of concentrates and average metallic content of each kind produced at concentration mills in Utah, 1903–1913.[a]

Kind of concentrates.	Quantity.	Average metallic content.					Average gross value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1904	885	$19.85	31.42	0.16	.....	.....	$38.50
1905	15	44.07	75.47	.....	.....	.....	90.07
1906	59	138.34	1.73	.....	.....	.....	139.51
1907	10	36.80	77.20	.....	.....	.....	87.80
1913	22	51.68	64.73	.....	.....	.....	90.82
Copper:							
1904	9,215	2.85	1.28	25.90	.....	.....	69.89
1905	32,266	2.22	1.58	18.26	.....	.....	60.16
1906	35,322	2.34	1.62	16.79	.....	.....	68.26
1907	51,224	2.82	1.71	18.08	.....	.....	76.25
1908	121,046	3.02	1.45	22.06	.....	.....	62.03
1909	147,976	3.31	1.56	23.04	.....	.....	64.01
1910	181,201	4.67	2.16	25.38	.....	.....	70.30
1911	228,583	3.85	1.89	23.18	.....	.....	62.79
1912	261,941	2.91	1.33	19.67	.....	.....	68.32
1913	382,663	1.65	.85	16.51	.....	.....	53.30
Lead:							
1903	37,943	2.14	42.88	.89	31.17	.....	53.92
1904	49,826	1.68	35.54	.57	25.50	.....	45.69
1905	41,033	2.11	38.18	.75	24.75	.....	51.00
1906	64,437	1.61	23.62	1.38	26.35	.....	53.06
1907	84,016	1.76	18.46	.73	19.48	.....	37.50
1908	58,763	1.22	18.25	1.13	20.44	.....	31.05
1909	93,934	1.41	14.95	.97	22.36	.....	30.93
1910	92,103	1.48	15.89	.67	24.89	.....	33.65
1911	107,006	1.46	17.90	.65	21.35	.....	31.80
1912	103,999	1.37	21.61	1.11	21.88	.....	38.02
1913	129,413	1.37	16.82	1.09	20.83	.....	32.71
Zinc:							
1905	90	.69	36.33	2.08	3.33	33.75	72.31
1906	8,921	.51	8.22	.....	.....	18.77	29.00
1908	3,153	.02	.81	.....	.07	22.29	21.46
1909	18,969	.40	4.87	.....	1.93	18.36	24.44
1910	12,710	.....	11.04	.....	3.50	34.39	46.19
1911	21,482	.06	5.69	.03	2.56	30.62	40.38
1912	14,992	.35	11.69	.28	3.13	35.74	60.62
1913	13,802	.29	9.76	.25	2.87	33.09	46.54
Copper-lead:							
1903	14,210	.24	15.85	3.20	9.12	.....	25.21
1904	16,982	.21	13.61	2.95	7.22	.....	21.86
1905	22,018	.35	15.03	3.00	7.95	.....	26.35
1906	3,249	.73	11.57	3.90	12.40	.....	37.80
1907	3,224	.97	25.12	4.23	12.53	.....	47.75
1908	1,090	.69	20.95	4.04	10.27	.....	31.09
1909	438	.56	18.13	7.50	9.32	.....	37.49
1910	2,152	.34	28.88	3.60	13.27	.....	36.75
1911	291	.27	31.00	5.04	7.88	.....	36.40
1912	426	.05	35.23	7.06	10.18	.....	54.18
Lead-zinc:							
1905	3,794	.47	9.06	.....	4.76	25.19	40.20
1906	375	.62	17.50	.....	5.00	22.50	45.67
1907	574	.22	16.40	.....	4.04	22.54	41.92
1909	1,084	.45	12.16	.07	6.12	19.35	33.12
1910	12,714	.45	8.18	.04	4.21	16.59	23.14

[a] Value figured from commercial value for each metal for each calendar year.

Mine production of gold, silver, copper, lead, and zinc from Utah crude ore shipped to smelters in 1913, by counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver	41,961	328.41	242,904	1,116,496	6,801,127	4,818,392	$895,639
Boxelder	5,248	2.00	852	373,493	10,087	.....	89,891
Iron	2	.82	1,037	22	.....	.....	646
Juab	376,627	66,585.59	5,591,179	9,292,110	22,480,131	751,651	7,225,013
Millard	12	.....	12	36	6,193	.....	286
Morgan	52	.29	97	.....	23,994	.....	1,121
Piute	85	112.95	1,826	3,437	.....	.....	3,970
Salt Lake	660,770	48,865.84	1,649,943	19,449,913	47,466,585	.....	7,108,585
Summit	30,296	2,279.07	1,846,181	965,571	18,292,583	.....	2,116,742
Tooele	27,566	542.12	312,540	404,160	8,389,584	1,186,065	698,188
Utah	18,040	1,454.20	264,907	6,199	4,483,394	2,967,081	554,451
Wasatch	5,291	186.17	205,588	191,943	2,214,444	.....	255,210
Total	1,165,950	120,357.46	10,117,066	31,994,380	110,168,122	9,723,189	18,949,742
Subdivision by kinds of ore:							
Dry or siliceous	127,253	19,559.62	1,769,019	1,447,177	1,019,255	.....	1,741,981
Copper	692,892	70,385.88	1,988,922	25,719,652	147,344	.....	6,649,343
Lead	357,196	30,343.39	6,241,585	4,582,358	107,078,919	.....	9,818,909
Zinc	15,300	.....	13,576	.....	871,435	9,416,157	573,847
Copper-lead	2,740	68.57	103,931	245,193	909,499	.....	142,214
Lead-zinc	569	.....	33	.....	141,670	307,032	23,448

Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Utah, 1903–1913.

Kind of crude ore.	Quantity.	Average metallic content.					Average gross [a] value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1903	67,463	$10.96	13.82	0.63	0.28	.....	$20.39
1904	53,036	9.79	14.53	.21	.62	.....	19.30
1905	57,373	4.06	13.14	.39	1.25	.....	14.48
1906	88,912	6.00	9.94	.41	.67	.....	15.11
1907	37,002	14.45	9.12	.16	.07	.....	21.19
1908	7,646	5.98	25.56	.09	.45	.....	20.08
1909	21,101	8.92	18.86	.71	.85	.....	21.30
1910	93,772	2.37	5.70	.55	.28	.....	7.14
1911	189,424	5.30	12.94	.86	.67	.....	14.91
1912	196,846	5.23	17.33	.84	.45	.....	19.08
1913	127,253	3.17	13.90	.57	.40	.....	13.69
Copper:							
1903	517,882	2.79	4.42	2.57	.....	.....	12.23
1904	677,587	2.99	4.17	2.64	.....	.....	12.16
1905	821,154	3.64	4.33	2.48	.....	.....	14.02
1906	767,068	3.56	3.58	2.52	.02	.....	15.75
1907	908,319	3.12	3.42	2.27	.....	.....	14.49
1908	644,488	2.99	3.54	2.33	.09	.....	11.09
1909	753,278	2.56	3.00	2.34	.10	.....	10.31
1910	568,845	2.64	2.91	2.65	.02	.....	10.95
1911	640,729	2.36	3.01	2.55	.03	.....	10.34
1912	572,354	2.46	3.82	2.18	.19	.....	12.19
1913	662,892	3.19	3.00	1.94	.01	.....	10.03
Lead:							
1903	150,862	2.12	46.17	1.07	24.33	.....	50.43
1904	187,820	1.68	33.67	.89	22.99	.....	43.02
1905	179,679	2.30	25.57	.62	21.54	.....	40.07
1906	266,450	1.79	22.52	.49	16.50	.....	37.82
1907	222,685	2.56	24.38	.45	18.20	.....	39.73
1908	130,931	2.49	35.18	.64	23.84	.....	42.86
1909	220,616	2.83	32.60	.53	23.10	.....	41.04
1910	221,648	2.48	26.74	.54	15.71	.....	32.12
1911	261,333	1.82	20.66	.50	16.12	.....	28.51
1912	252,888	1.68	20.06	.60	16.42	.....	30.89
1913	357,196	1.76	17.47	.64	14.99	.....	27.49

[a] Figured from commercial value for each metal for each calendar year.

Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Utah, 1903–1913—Continued.

Kind of crude ore.	Quantity.	Average metallic content.					Average gross value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Zinc:	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1904	522	.....	1.15	.....	.....	11.80	$14.16
1905	5,445	$0.20	2.14	.....	.....	20.37	17.18
1906	6,461	.....	2.50	.....	.....	22.91	29.66
1907	12,351	.....	2.70	.....	.....	21.20	26.79
1908	29	.21	10.64	.....	5.53	27.73	53.75
1909	3,264	.....	.....	.....	.....	27.84	30.07
1910	4,876	.05	1.23	0.01	2.12	25.94	30.61
1911	1,316	.....	.....	.....	.....	23.35	34.02
1912	3,891	.22	1.51	.....	2.93	29.80	45.30
1913	15,300	.....	.89	.....	2.55	30.77	37.61
Copper-lead:							
1903	2,129	1.10	18.00	13.47	16.20	.....	58.66
1904	5,100	.78	5.42	18.59	16.45	.....	52.98
1905	1,384	2.66	32.34	5.06	27.51	.....	64.50
1906	6,193	.96	27.94	5.53	9.56	.....	51.98
1907	8,310	1.90	26.22	4.81	6.99	.....	52.40
1908	2,674	.38	21.77	4.01	23.82	.....	56.70
1909	4,416	.44	22.30	5.93	16.09	.....	41.27
1910	5,269	.45	30.12	3.86	20.81	.....	54.95
1911	2,219	.98	32.17	5.39	16.11	.....	43.45
1912	2,987	1.04	40.96	4.42	12.54	.....	50.42
1913	2,740	.52	27.93	4.47	15.60	.....	51.90
Lead-zinc:							
1909	*b* 697	.18	9.05	.....	12.23	28.39	50.52
1910	*c* 2,170	.05	.39	.01	9.46	30.21	50.99
1911	*d* 5,923	.17	1.03	.00	10.76	23.69	37.44
1912	*e* 1,402	.....	.44	.....	7.14	36.20	43.86
1913	*f* 649	.....	.06	.....	13.45	28.99	41.22

a Figured from commercial value for each metal for each calendar year.
b All Horn Silver mine.
c Horn Silver, Cedar Talisman, and Scranton.
d Largely Horn Silver and Scranton.
e Largely Yankee, May Day, and Hidden Treasure.
f May Day, Yankee, Hidden Treasure, and Scranton.

A classification of kinds of crude ore smelted, separated into oxidized and sulphide ores, with average content, is shown in the two following tables:

Oxidized and sulphide crude ores with metal content, by kinds, including mixed dry ores and carbonate ores, produced in Utah and shipped to smelters in 1913.

Kind of ore.	Quantity.	Metal content.					Total value.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	127,253	19,559.62	1,769,019	1,447,177	1,019,265	.....	$1,741,981
Copper:							
Oxidized	168,802	30,948.97	1,248,498	5,766,554	146,935	.....	2,799,087
Sulphide	494,090	39,486.91	740,519	14,963,998	419	.....	3,890,256
Lead:							
Oxidized	147,315	19,325.16	4,366,208	1,543,490	41,113,981	.....	5,151,688
Sulphide	209,881	11,018.20	5,975,977	5,038,868	67,705,808	.....	4,907,221
Zinc:							
Oxidized	5,020	.....	.....	.....	.....	4,829,427	350,809
Sulphide	7,500	.....	13,376	.....	871,446	6,760,130	314,984
Copper-lead:							
Oxidized	1,819	33.02	72,611	103,943	709,777	.....	106,491
Sulphide	921	26.55	24,900	86,200	166,709	.....	56,746
Lead-zinc:							
Oxidized	504	.....	31	.....	241,670	307,003	20,448
Total	1,165,950	120,357.46	10,117,666	31,994,240	116,188,122	9,725,189	18,949,742

Oxidized and sulphide crude ores, averages per ton, by kinds, produced in Utah and shipped to smelters in 1912–13.

Kind of ore.	Quantity.	Average metallic content.					
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value per ton.
	Short tons.	*Fine ounces per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1912	196,846	0.25	17.33	0.84	0.45	.....	$19.08
1913	127,253	.15	13.90	.57	.40	.....	13.69
Copper:							
Oxidized—							
1912	147,271	.19	9.60	3.72	.74	.....	22.85
1913	168,802	.18	7.39	2.60	.04	.....	16.34
Sulphide—							
1912	425,083	.09	1.82	1.65	.....	.....	8.50
1913	494,090	.08	1.50	1.72	.....	.....	7.87
Lead:							
Oxidized—							
1912	119,195	.11	26.51	.45	14.15	.....	32.85
1913	147,315	.13	29.64	.52	14.70	.....	35.17
Sulphide—							
1912	133,693	.05	14.31	.74	18.45	.....	28.97
1913	209,881	.05	8.93	.72	15.19	.....	22.09
Zinc:							
Oxidized—							
1912	7,360	.01	1.67	.....	2.80	30.05	45.30
1913	8,020	.....	.....	.....	.....	28.82	32.28
Sulphide—							
1912	2,031	.....	1.15	.....	5.22	28.89	45.27
1913	7,280	.....	1.86	.....	5.99	32.92	43.26
Copper-lead:							
Oxidized—							
1912	3,154	.05	41.49	4.13	12.66	.....	51.60
1913	1,819	.02	43.78	4.45	20.33	.....	58.51
Sulphide—							
1912	233	.04	33.72	6.97	11.43	.....	54.80
1913	921	.04	26.49	4.52	9.21	.....	38.85
Lead-zinc:							
Oxidized—							
1912	1,402	.....	.44	.....	7.18	26.90	43.86
1913	569	.....	.06	.....	12.45	26.98	41.22
Total:							
1912	1,036,268	.13	10.45	1.53	4.28	.31	18.52
1913	1,165,950	.10	8.68	1.37	4.72	.42	16.25

The State output by counties follows, giving the metallic output of each with total value, and also table with tonnages and average values compared for 1912 and 1913.

Mine production of gold, silver, copper, lead, and zinc in Utah in 1913, by counties.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.		
	Quantity.	Value.	Quantity.	Value.		Quantity.	Value.
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Beaver	.....	.....	1,117.85	$23,108	$23,108	344,437	$208,040
Boxelder	.....	.....	253.78	5,246	5,246	1,205	728
Garfield	41.12	$850	.....	.....	850	7	4
Grand	6.68	138	18.62	385	523	4	3
Iron	.....	.....	.82	17	17	1,037	626
Juab	.....	.....	67,002.76	1,385,070	1,385,070	5,600,617	3,382,773
Millard	.....	.....	.....	.....	.....	12	7
Morgan	.....	.....	.29	6	6	97	59
Piute	.....	.....	2,504.90	51,781	51,871	9,739	5,882
Salt Lake	.....	.....	85,972.73	1,777,214	1,777,214	2,504,021	1,512,429
San Juan	25.01	517	.....	.....	517	2	1
Summit	.....	.....	3,591.46	74,242	74,242	3,090,282	1,866,530
Tooele	.....	.....	9,803.87	202,664	202,664	640,249	386,710
Uinta	20.07	415	.....	.....	415	2	1
Utah	.....	.....	1,478.44	30,562	30,562	265,850	160,573
Wasatch	.....	.....	629.55	13,014	13,014	627,274	378,874
Total	92.88	1,920	172,375.07	3,563,309	3,565,229	13,084,835	7,903,240

Mine production of gold, silver, copper, lead, and zinc in Utah, in 1913, by counties—Continued.

County.	Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Beaver	3,137,234	$486,271	10,454,583	$460,002	5,522,324	$309,250	$1,486,671
Boxelder	622,206	96,442	15,832	697	.....	.....	103,113
Garfield	.....	.....	.....	.....	.....	.....	854
Grand	.....	.....	.....	.....	.....	.....	526
Iron	22	3	.....	.....	.....	.....	646
Juab	9,293,661	1,440,518	22,508,439	990,371	761,212	42,628	7,241,360
Millard	36	6	6,193	273	.....	.....	286
Morgan	.....	.....	23,994	1,056	.....	.....	1,121
Piute	3,904	605	46,458	2,044	.....	.....	60,312
Salt Lake	145,065,188	22,485,104	72,111,025	3,172,885	3,421,724	191,616	29,139,248
San Juan	.....	.....	.....	.....	.....	.....	518
Summit	1,343,846	208,296	32,617,400	1,435,166	2,459,783	137,748	3,721,982
Tooele	1,522,596	236,002	14,619,866	643,274	1,202,568	67,344	1,535,994
Uinta	.....	.....	.....	.....	.....	.....	416
Utah	6,945	1,077	4,531,687	199,393	2,969,793	166,308	557,913
Wasatch	450,324	69,800	9,191,313	404,418	2,520,423	141,144	1,007,250
Total	161,445,962	25,024,124	166,126,790	7,309,579	18,857,827	1,056,038	44,858,210

Tons of ore sold or treated, number of deep mines producing, and value of ores in Utah in 1912 and 1913, by counties.

County.	Ore sold or treated (short tons).		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1913	Increase (+) or decrease (−).	1912	1913	1912	1913	1912	1913
Beaver	168,158	− 41,410	18	24	$5.34	$8.84	$0.91	$1.37
Box Elder	6,718	+ 363	9	3	23.31	15.35	.76	.89
Grand	18	+ 17	1	1	36.00	21.44	35.00	21.44
Iron	2	− 109	3	2	7.90	323.00	5.48	321.50
Juab	383,977	− 4,605	42	56	23.18	18.86	15.15	12.42
Millard	12	− 9	2	1	40.43	23.83	17.14	.58
Morgan	52	− 82	1	1	26.93	21.56	2.78	1.25
Piute	11,809	+ 10,474	4	7	5.01	5.11	3.89	4.88
Salt Lake	9,195,624	+2,619,077	53	51	3.75	3.17	.48	.36
Sevier	.....	− 120	1	.....	2.67	.....	.02	.....
Summit	216,293	− 1,697	15	15	17.75	17.21	8.62	8.97
Tooele	147,483	− 121,122	32	29	7.07	10.41	2.92	4.00
Utah	18,186	− 20,016	13	18	25.03	30.68	11.15	10.51
Wasatch	54,234	− 8,447	3	2	19.57	18.57	6.98	7.22
Washington	.....	− 18	1	.....	10.89	.....	10.89	.....
Total	10,202,566	+2,432,296	198	210	5.52	4.39	1.64	1.12

[a] Value per ton, placer product excluded.

REVIEW BY COUNTIES.

BEAVER COUNTY.

Although Beaver County was credited with a smaller production of ore in 1913, the output decreasing from 209,568 tons in 1912 to 168,158 tons in 1913, the total value of the gold, silver, copper, lead, and zinc output increased from $1,118,787 to $1,486,671. There was an increase in all metals, with the exception of gold, which decreased from $34,115 to $23,108 in 1913. The silver production, valued at $157,479 in 1912, increased to $208,040 in 1913. The copper yield increased in quantity, but in value decreased from $501,666 to $486,271, or $15,395 less than in 1912. A gain of $115,632 was reported in the lead production, the output increasing from $344,370 in 1912 to $460,002 in 1913. The spelter output from zinc ores mined also increased, from a total value of $81,157 in 1912 to $309,250 in 1913.

Reports from 24 deep mines in 1913, against 18 in 1912, gave a yield of 168,158 tons of ore, which was 41,410 tons less than in 1912. The average value per ton of this ore increased from $5.34 in 1912 to $8.84 in 1913, and the average value of the gold and silver content increased from $0.91 to $1.37 per ton. Of the ore mined, 104,850 tons were concentrated, producing copper, lead, and zinc concentrates carrying values in gold and silver and having a total value of $417,806, or $32.98 per ton. The larger part of the concentrates produced came from the milling of low-grade disseminated ores milled at Newhouse from the Cactus mine. Some tests were made in the concentration of tailings containing zinc from the dump of the Horn Silver mine. Crude ore shipped aggregated 41,961 tons, largely sulphide, and yielded at smelters gold, silver, copper, lead, and zinc, valued at $895,639, or an average value of $21.34 per ton. In the eastern part of the county the Newton district attracted attention with reports of success in the milling of gold ores by amalgamation and cyanidation.

The total production of gold, silver, copper, lead, and zinc in Beaver County from 1860 to 1913 aggregates a gross value of $43,073,986, out of which was paid by the known dividend payers $7,532,704. During the period as shown in the following table (each year's metal output being figured at commercial prices) the value of the output amounted to $646,848 in gold, $18,790,189 in silver, $6,403,676 in copper, $16,344,825 in lead, and $652,653 in zinc.

Quantity of ore sold or treated in Beaver County, Utah, 1860–1913, number of mines producing, and total output of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.[a]
		Short tons.	*Value.*	*Fine ounces.*	*Short tons.*	*Short tons.*	*Short tons.*	
1860								
1875[b]			$15,814	257,720		1,850		$559,742
1876			[cd] 7,028	[cd] 226,625		[cd] 2,588		585,649
1877			[d] 5,891	[d] 420,000		[de] 3,264		868,931
1878			[d] 8,372	[d] 646,625		[de] 3,500		1,003,991
1879			[d] 8,786	[df] 756,700		[de] 3,955		1,180,605
1880			[d] 11,370	[df] 1,108,530		[de] 5,055		1,791,656
1881			[d] 8,785	[df] 1,501,341		[de] 6,285		2,308,701
1882			[d] 19,990	[df] 1,857,586		[de] 22,712		4,363,413
1883			[d] 11,990	[df] 1,652,980	[dg] 5	[de] 15,099		3,146,919
1884			[d] 10,005	[df] 1,625,300	[de] 3	[de] 12,400		2,732,362
1885			[d] 2,584	[df] 420,000	[de] 5	[de] 4,900		835,264
1886			[h] 6,202	[h] 250,000	[de] 13	[de] 1,900		431,499
1887			[h] 6,202	[h] 235,188	[de] 32	[de] 1,562		386,236
1888			[h] 2,584	[h] 191,100	[de] 38	[de] 1,879		360,203
1889			[h] 6,408	[h] 325,330	[de] 425	[de] 4,565		783,030
1890			[h] 5,168	[h] 560,880	[de] 137	[de] 5,409		1,123,691
1891			[h] 2,274	[h] 677,160	[de] 432	[de] 7,578		1,434,951
1892			[h] 2,687	[df] 736,256	[de] 30	[de] 9,447		1,405,940
1893			[h] 3,514	[h] 720,144	[de] 25	[de] 7,130		1,098,283
1894			[h] 2,584	[df] 421,822	[de] 44	[de] 5,128		615,120
1895			[h] 14,718	[df] 700,094	[de] 5	[de] 7,346		940,980
1896			[h] 10,439	[h] 330,510	[de] 2	[de] 4,557		509,176
1897			[h] 17,096	[h] 296,824	[de] 4	[de] 6,090		634,555
1898			[h] 14,884	[h] 309,986	[he] 70	[he] 4,076		524,863
1899			[h] 22,408	[h] 244,939	[he] 459	[he] 2,496		550,654
1900			[h] 5,809	[df] 146,932	[he] 385	[he] 1,958		396,995
1901			[h] 20,734	[h] 427,382	[he] 466	[he] 3,454		729,899
1902			[h] 26,522	[h] 221,867	[he] 457	[he] 2,511		461,564
1903			[h] 17,261	[h] 100,214	[he] 233	[he] 2,783		382,922
1904			[i] 13,040	[i] 120,984	[j i] 825	[i] 3,769	[i] 166	645,316
1905	5	143,233	[i] 38,512	[i] 180,912	[i] 1,778	[i] 2,101	[i] 2,765	1,202,737
1906	14	244,777	[i] 56,396	[i] 323,807	[i] 2,703	[i] 2,662	[i] 390	1,667,812
1907	17	234,092	[i] 55,968	[i] 351,147	[i] 2,820	[i] 2,229	[i] 520	1,713,251
1908	21	223,021	[i] 47,147	[i] 150,193	[i] 2,853	[i] 1,544	[i] 27	1,012,319
1909	20	57,867	[i] 15,771	[i] 273,977	[i] 623	[i] 2,883	[i] 328	603,782
1910	21	83,748	[i] 17,114	[i] 339,881	[i] 564	[i] 3,118	[i] 257	646,111
1911	29	259,695	[i] 47,568	[i] 201,259	[i] 1,870	[i] 2,267	[i] 32	829,406
1912	18	209,568	[i] 34,115	[i] 256,064	[i] 1,520	[i] 3,826	[i] 588	1,118,787
1913	24	168,158	[i] 23,108	[i] 344,437	[i] 1,569	[i] 5,227	[i] 2,761	1,486,671
Total			646,848	19,912,696	[k] 20,395	191,103	7,634	43,073,986

[a] Average commercial prices used for each metal to make total for each calendar year.

[b] The prosperous years of the county began in 1872, when Shauntie, Shenandoah City, Elephant City, and South Camp were thriving. Most of the ore produced was treated at the Shauntie smelter, consisting of two small stacks erected in the summer of 1873 (closed 1877). * * * In 1875 the Troy furnace (only ran a few months) was erected 5 miles south of Milford to treat Mammoth ores. * * * The oldest producing mine was the Rollins property in the Lincoln district. It is claimed by the Mormons that it is the oldest mine in Utah. They worked between 1860 and 1863 and made a few tons of lead in a primitive way. * * * A 15-ton furnace was built in the fall of 1875 (operated two years). These extracts are from Tenth Census Report, vol 13, pp. 472–475. Another authority states that in the fifties (1854) a Mormon named Isaac Grundy erected the first furnace on the Pacific coast near the Rollins mine and melted the lead ore from this property, producing bullion which was hauled to Salt Lake and made into bullets. Reference to this fact is taken from Eissler's preface, "The Metallurgy of Argentiferous Lead."

[c] With the discovery of the Horn Silver mine Sept. 24, 1875, steady shipments of ore were made in 1876 until furnaces were erected in 1876. From 1880 to 1884 it was one of the largest producers of lead-silver ore in the State.

[d] Estimates by V. C. Heikes from a separation of the total output reported by the Director of the Mint are given in the annual reviews of the Salt Lake Tribune and of the U. S. Geol. Survey Mineral Resources, 1882–1897. Part of the records of some early producers were used in the estimates.

[e] Bulk of copper and lead produced from Horn Silver ores.

[f] Horn Silver mine yielded 1,865,230 ounces for the years 1879–1881; 1,552,981 ounces in 1882; 1,116,898 ounces in 1883; 1,560,000 ounces in 1884; 315,900 ounces in 1885; 636,256 ounces in 1892; 321,823 ounces in 1894; and 143,932 ounces in 1900.

[g] Cactus and Horn Silver estimated.

[h] Director of the Mint Reports.

[i] Mineral Resources U. S. Geol. Survey, 1904–1913.

[j] Cactus mine starts production.

[k] Estimate by B. S. Butler, U. S. Geol. Survey Prof. Paper 80, p. 117, 1913, places the total production of copper from 1870 to 1901, inclusive, at 4,327,047 pounds; estimate of V. C. Heikes is 5,160,790 pounds.

Beaver County was settled in 1856. Production of metals began as far back as 1854,[1] when the Mormons began working the old Spanish mine, which was subsequently known as the Rollins or Lincoln mine, in what was formerly called the "Pioneer" district but later the Lincoln district. Here lead ore was mined and reduced in a furnace (said to be the first furnace erected on the Pacific slope) in the fifties to make lead bullion for the manufacture of bullets. The Star districts began their prosperity in 1872 and continued until 1875.[2] Then there were the thriving camps of Shauntie, Shenandoah City, Elephant City, and South Camp. Most of the ore produced was treated at the Shauntie smelter. There were two other small smelters in the same district, but they were not very successfully operated. In 1876,[3] a year after the discovery of the Horn Silver mine in the San Francisco district, it became important as a producer of lead-silver ore. This mine was largely developed by individual owners and a smelting works was erected by the year 1879.

> Previous to the acquisition of the property by the Horn Silver Mining Co. (1879) the ores were smelted at the company's works at Frisco and by the Frisco Mining & Smelting Co., which also operated a smelter at Frisco. * * * The cost of smelting at Frisco was too high. * * * On the completion of the Utah Southern Railroad to the mine, in the summer of 1880, the company constructed a smelting plant at Francklyn, about 6 miles south of Salt Lake City. Smelting of ores was begun at this plant in June, 1881. * * * In June, 1882, operations at the Frisco smelter were discontinued. * * * The Francklyn plant was closed in March, 1885, * * * and smelting was not resumed. The ores were afterward shipped to custom smelters.[4]

From 1880 to 1884 the Horn Silver mine was one of the largest producers of lead and silver in the State and the county production given in the foregoing table from 1876 to 1913 is largely influenced by its production, together with that of the Cactus mine between 1905 and 1913.

Beaver Lake district.—The O. K. and Baby Jack properties were operated, producing oxidized copper ores in 1913.

Lincoln district.—In 1913 some slag from early smelting operations was shipped. The slag carried principally lead and silver, with small quantities of copper and gold.

Newton district.—The Rob Roy and Sheep Rock properties were productive in 1913, the latter yielding milling ore which was treated by amalgamation and concentration, with tests by cyanidation on the tailings.

Preuss district.—Some copper-lead ore, containing silver and gold, was shipped from the Hendrickson group in 1913.

Rocky district.—An important tonnage of oxidized copper ore containing silver was shipped in 1913 from the Old Hickory, Montreal, and Copper Ranch properties.

San Francisco district.—In 1913 five producers reported the output of 140,361 tons of ore and old slag containing $19,115 in gold, 166,232 ounces of silver, 2,042,129 pounds of copper, 6,523,687 pounds of lead, and 5,497,062 pounds of zinc, valued in all at $1,030,927. In 1912 there were 189,374 tons of ore and slag reported in the district output, with a total value of $801,355. The Cactus mine resumed

[1] Fabian, Bentham, The resources of Utah, Salt Lake City, Utah, 1872.
[2] Tenth Census, United States, vol. 13, Precious metals, p. 472.
[3] Idem, p. 464.
[4] Butler, B. S., Geology and ore deposits of the San Francisco and adjacent districts: U. S. Geol. Survey Professional Paper 80, p. 190, 1913.

operations in March, 1913, and yielded the largest part of the ore tonnage, consisting of low-grade copper-bearing porphyry, which was milled at Newhouse and the copper sulphide concentrates were shipped to the smelters. Ore milled during the last few months averaged approximately 1.45 per cent of copper, on which it is reported that a 65 per cent recovery was made. The Horn Silver mine, with the next largest output, yielded mixed lead sulphides and carbonates and also an important tonnage of zinc sulphide ore. The old slag was shipped by lessees from the old smelter dumps on the property. Copper and zinc concentrates produced in the district aggregated 104,850 tons; ore of shipping grade, 14,864 tons; and in addition to the crude ore there were 20,647 tons of old slag loaded and shipped to the smelters.

There were shipped from the Horn Silver mine [1] and surface property 25,184 tons of ore, concentrates, and slag. The slag was from early operations of the smelter and aggregated 6,819 tons, netting $3,025. From the mine there were shipped 8,104 tons of lead-silver ore, netting $66,493, and 6,997 tons of zinc sulphide ore, netting $68,770. The tailings dump yielded some zinc concentrates, which were shipped with the crude ore. In 1912 the shaft caved from the 900-foot level to the lowest workings and repairs were immediately begun; the shaft is now in safe condition down to the 900-foot level, repairs are to be continued to the 1,100-foot level.

Star districts (North and South).—Shipments aggregating 8,728 tons of silver-lead ore, including one shipment of zinc ore, were made by 10 producers, against 5,144 tons shipped by 7 producers in 1912. The total output, valued at $284,828 in 1913, contained $720 in gold, 153,774 ounces of silver, 124,457 pounds of copper, 3,875,524 pounds of lead, and 25,262 pounds of zinc. The zinc was from the Cedar Talisman property, and the Moscow mine was the largest producer of lead ore. Others contributing to the lead output were the Red Warrior, Hub, and Lady Bryan, Blue Bird, Flora, Hoosier Boy, and Big Gentile.

BOX ELDER COUNTY.

Lucin district.—Lessees operating on the Copper Mountain group of the Salt Lake Copper Co. shipped the greater part of the district output, consisting of 6,298 tons of copper and iron ore for flux. There was also produced a small quantity of oxidized lead ore from the Tecoma mine.

Park Valley district.—The Sussannah property produced some gold bullion from ores treated by amalgamation. It was the only producer reporting output in 1913.

GRAND COUNTY.

Miners Basin district.—The Tornado mill was operated on test lots of ore presumably taken from the Tornado property. Gold and silver bullion was recovered by amalgamation.

IRON COUNTY.

Stateline district.—Lessees operated the Ophir property and made shipments of product containing principally silver.

[1] Horn Silver Mining Co., Ann. Rept. for year ending Dec. 31, 1913.

JUAB COUNTY.

In 1913 there were 56 mines producing in Juab County, against 42 in 1912. The total value of the product of gold, silver, copper, lead, and zinc was $7,241,360, contained in 383,977 tons of ore, which is 4,605 tons less than was produced in 1912. The mine output from Juab County is largely from the Tintic district.

Detroit district.—In 1913 the Ibex property was operated by lessees, who shipped oxidized copper ore carrying values in gold and silver.

Fish Springs district.—The Utah mine was the principal producer. A jig product is made from the working of the old mine dump by lessees and shipped with the carbonate lead-silver ore from the mine.

Mount Nebo district.—Shipments of lead ore were made from the Nebo Star, Freddie, Highland, and Eva properties, the last two shipping some ore containing zinc.

Tintic district.—Mining in the Tintic district, which was organized in 1870, is said to have begun with the first discovery of mineral on the Sunbeam claim, located in December, 1869. But little work was done on the properties then located until the fall of 1870. The active camps at that time were Eureka, Silver City, and Diamond City. The first smelters and mills were partly successful. In 1871, in June and October, the Utah smelter at Homansville, treating Scotia mine lead ore, and the Tintic smelter at Diamond City, treating Shower mine ore, were completed. During 1872 at Homansville the Eureka Mining Co. built a 12-stamp mill to work its own ores, and the Wyoming Silver Mining Co. was operating a custom mill consisting of 10 stamps and a Stedefelt furnace, said to be the first in Utah. Among the mines discovered up to January, 1873, were the claims of the Mammoth-Copperopolis Co. (later the Ajax and Golden Chain); the ores from the property yielded a large percentage of copper with silver and gold. The returns on the shipments to Swansea, Wales, are said to have averaged in some instances from $200 to $300 per ton. At the same time the Mammoth mine was producing similar ores which were shipped to England and subsequently both the Mammoth properties had mills for the treatment of the lower-grade ores. During this period the Eureka Hill property was producing ore, which was milled at Homansville. Beginning in 1877, as shown by the records furnished the Geological Survey, the Eureka Hill mine became an important shipper of lead-silver ore. In 1883 the Bullion-Beck mine began production and the Centennial Eureka in 1886. The next heavy producers of lead-silver ore were the Humbug and the Uncle Sam mines in 1896–97, and in 1905 the Beck Tunnel began to ship. In the Colorado mine a very rich deposit of carbonate-lead-silver ore was opened and shipments began in 1907. The Sioux began shipments of similar ores in 1908 and the Iron Blossom mine in 1909. Since that year no producers of exceptional importance have been discovered.

From 1870 to and including 1913 the mines produced (figuring each year's production at commercial prices), $28,962,370 in gold, $70,601,175 in silver, $21,673,793 in copper, $26,671,505 in lead, and $457,378 in zinc. The total gross value amounted to $148,366,221, out of which there were paid in dividends (partly estimated), $27,551,090, to which 28 known dividend payers contributed. The table following shows the quantity and total value of each year's metal output:

Quantity of ore sold or treated in Tintic district, Juab and Utah counties, in 1869–1913, number of mines producing, and total output of gold, silver, copper, lead, and zinc.

Year.	Number or producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.[a]
		Short tons.	*Value.*	*Fine ounces.*	*Short tons.*	*Short tons.*	*Short tons.*	
1869–1876[b]			$511,215	894,000	1,279	3,872		$2,900,238
1877			[c] 41,344	[c] 150,000	[c d] 157	[c e] 147		247,019
1878			[c] 51,680	[c] 130,000	[c d] 56	[c] 201		237,776
1879			[c] 51,680	[c] 250,000	[c d] 55	[c] 603		401,754
1880			[f d] 91,349	[f d] 181,545	[c d] 43	[c] 353		353,807
1881			[c g] 48,207	[c g] 151,073	[c d] 150	[c] 226		295,206
1882			[c] 60,010	[d] 232,558	[c d] 253	[c e] 299		451,045
1883			[d] 41,344	[c g] 523,798	[c d] 141	[c] 450		707,971
1884			[d] 31,008	[c g] 619,194	[c d] 81	[c] 2,780		945,037
1885			[d] 17,943	[d] 868,925	[c d] 99	[c] 3,892		1,272,683
1886			[d] 47,545	[d e] 825,000	[c d e] 762	[c e] 2,985		1,308,239
1887			[d] 66,150	[d] 1,412,463	[c d] 1,000	[c] 3,169		1,991,574
1888			[d] 146,977	[d] 1,201,620	[c d] 1,100	[c] 2,927		1,903,687
1889			[d] 308,837	[d] 2,055,700	[c d] 935	[c] 4,989		2,882,809
1890			[d] 509,209	[d] 3,801,700	[c d] 434	[c] 5,441		5,126,238
1891			[d] 401,943	[d] 2,901,730	[c d] 344	[c] 6,574		3,928,069
1892			[d] 340,465	[d] 2,011,642	[c d] 483	[c] 4,716		2,580,001
1893			[d] 312,083	[d] 1,990,860	[c d] 160	[c] 3,532		2,160,853
1894			[d] 373,457	[d] 2,582,033	[c d] 410	[c] 4,028		2,343,907
1895			[d] 568,992	[d] 3,517,166	[c d] 787	[c] 5,642		3,384,642
1896			[d] 836,589	[d] 3,955,843	[c d] 1,502	[c] 6,609		4,247,637
1897			[c] 765,643	[c] 2,877,600	[c] 1,250	[c] 10,671		3,560,508
1898			[c] 788,341	[c] 3,389,507	[c] 1,037	[c] 14,530		4,149,608
1899			[c] 928,517	[c] 3,329,833	[c] 1,721	[c] 19,040		5,228,575
1900			[c] 1,557,726	[c] 4,809,971	[c] 3,026	[c] 18,420		7,165,551
1901			[c] 830,160	[c] 2,685,735	[c] 3,779	[c] 12,194		4,752,448
1902			[h] 689,282	[h] 2,978,394	[h] 2,636	[h] 10,133		3,741,932
1903			[h] 1,364,072	[h] 3,620,362	[h] 4,012	[h] 6,240		4,942,486
1904	35	[h] 262,680	[h] 1,487,558	[h] 3,938,630	[h] 4,518	[h] 11,061		5,839,740
1905	31	[h] 266,761	[h] 2,086,656	[h] 3,951,348	[h] 5,491	[h] 9,351		7,065,600
1906	31	[h] 317,576	[h] 1,925,066	[h] 4,610,794	[h] 3,661	[h] 16,011		8,252,607
1907	40	[h] 278,504	[h] 2,337,270	[h] 4,949,082	[h] 3,878	[h] 16,510		8,904,848
1908	42	[h] 269,104	[h] 1,307,464	[h] 4,118,440	[h] 2,854	[h] 12,523		5,295,591
1909	37	[h] 256,578	[h] 1,719,679	[h] 6,404,847	[h] 2,958	[h] 8,251		8,248,831
1910	40	[h] 300,631	[h] 1,370,320	[h] 5,222,742	[h] 4,497	[h] 18,777		6,985,068
1911	38	[h] 360,391	[h] 1,633,396	[h] 5,514,702	[h] 5,461	[h] 11,786		6,982,241
1912	40	[h] 423,830	[h] 1,900,731	[h] 7,073,104	[h] 6,670	[h] 12,178	1,855	9,803,640
1913	51	[h] 400,430	[h] 1,412,462	[h] 5,829,484	[h] 4,631	[h] 13,140	1,798	7,726,755
Total.			28,962,370	105,561,425	72,311	304,251	3,653	148,366,221

[a] Average commercial prices used for each metal to make total for each calendar year.

[b] In December, 1869, West Tintic first attracted attention, and the Sunbeam mine was located, becoming the first important producer later along with the Scotia; then the Eureka Hill, Mammoth, Shoebridge, Martha Washington, Black Dragon, Gray Eagle, and Swansea, all operated between 1870 and 1876. In 1873 the Mammoth-Copperopolis (Ajax) and the Crismon-Mammoth mines were the principal producers of copper in Utah.

[c] Estimates by V. C. Heikes from a separation of the total output reported by the Director of the Mint, or given in the annual reviews of the Salt Lake Tribune and the U. S. Geol. Survey Mineral Resources, 1882–1897. Part of the records of some early producers were used in the estimates.

[d] Estimated by Tower and Smith, who gave table and remarks on production, 1880–1896, in U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, pp. 615–616, 1897–98: "It is thought the production of silver and gold previous to 1880 did not exceed $2,000,000 in value. From 1880 to 1896, inclusive, the production in gold has been 201,967 ounces and in silver 28,308,092 ounces. In addition to the silver and gold, Tintic has produced a large amount of lead and copper. The only method of calculation of the lead and copper is by finding the ratio of copper to either gold or silver. As silver is more uniformly distributed in the ores than gold, this metal has been chosen as the basis of calculation. The average content of copper and lead in 240,000 tons of ores was 0.6 per cent and 13.5 per cent, respectively. The ores which have furnished the basis of this calculation are the reported output of about two-thirds of the mines of the district. The content of silver of these same ores averages 52.50 ounces per ton. On this basis there are 20 pounds of copper to every 87.5 ounces of silver, and 20 pounds of lead to every 3.8 ounces of silver. Applying these ratios to the total production of the camp it is shown that there should have been produced 6,470,000 pounds of copper and 74,495 tons of lead for the years from 1880 to 1896, inclusive, thus roughly estimated. These calculations, however, judged from other standpoints, seem to be somewhat low for copper and high for lead."

[e] In 1877 the Eureka Hill mine commenced to produce silver-lead heavily; in 1882 the Bullion Beck & Champion mine, a silver-lead producer; and in 1886 the Centennial-Eureka mine, although not a large producer of lead, yielded largely gold, silver, and copper.

[f] Figures originally 3,012 ounces of gold and 8,682 ounces of silver, corrected from Tenth Census Report, vol. 13, p. 314.

[g] Tower and Smith, U. S. Geological Survey Nineteenth Ann. Rept., pt. 3, p. 615, 1897–98, give, 1880–1888, 682 ounces; 1881, 105,354 ounces; 1883, 224,800 ounces; 1884, 612,194 ounces. These figures have been corrected from producers' reports, the Eureka Hill being the largest producer for the years given.

[h] U. S. Geol. Survey Mineral Resources, 1902–1913.

The Tintic district is largely in Juab County, in which all of the first discoveries of mineral were made. A small part of the district laps into Utah County, and in the following table the number of producers and metal produced in each county are given:

Metallic output of Tintic district in 1912 and 1913, by counties.

County.	Year.	Number of mines.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
			Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Juab	1912	34	386,539	87,275.99	6,554,091	13,331,493	17,924,578	542,499	$8,878,655
	1913	43	382,708	66,879.99	5,570,347	9,257,871	22,043,780	629,463	7,187,167
Utah	1912	6	37,291	4,671.91	519,013	7,633	6,431,463	3,167,238	924,985
	1913	8	17,722	1,447.86	259,137	3,996	4,235,532	2,967,081	539,588

Fifty-one producers in 1913 reported the shipments of ore aggregating 400,430 tons, against 40 producers in 1912 reporting the production of 423,830 tons of ore. The bulk of the ore output was of shipping grade. A small tonnage was concentrated at one of the concentration mills in the district, and an old tailings dump of one of these plants treated by the cyanide process yielded gold and silver bullion. The total production of the district amounted to $7,726,755, or an average of $19.30 per ton. In 1912 the output was valued at $9,803,640, or an average of $23.13 per ton; in 1911 the average value was $19.37 and in 1910 it was $23.23 per ton. Much of the old dump ore mined in the early days found a ready market in 1913 and is included in the total output. All metals, with the exception of lead, showed decreased yields. Gold production decreased from $1,900,731 in 1912 to $1,412,462 in 1913; the silver, valued at $4,349,959 in 1912, decreased to $3,521,008 in 1913; copper, valued at $2,200,956 in 1912, decreased to $1,435,590 in 1913; lead increased from $1,096,022 to $1,156,289 in 1913; and the spelter content of zinc ores decreased from $255,972 to $201,406 in 1913. All of the metals aggregated a total value of $7,726,755, a decrease of $2,076,885. In the following table the kinds of ore produced, the number of producers, and the metallic content of each kind of ore is given for the year 1913:

Mine production of Tintic district, Juab and Utah counties, in 1913, by kinds of ore and metal output of each.

Kind of ore.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Siliceous	19	129,231	19,527.34	1,695,358	1,398,490	851,778	.....
Copper	17	146,994	30,814.37	1,224,916	7,161,817	146,925	.....
Lead	29	117,562	17,981.26	2,907,303	698,513	25,200,358	.....
Zinc	9	6,265	.....	.....	.....	.....	3,497,546
Copper-lead	3	43	3.48	1,400	2,802	15,665	.....
Lead-zinc	2	335	1.40	507	245	64,586	98,998
Total	.....	400,430	68,327.85	5,829,484	9,261,867	26,279,312	3,596,544

The Centennial-Eureka mine [1] produced 100,442 rons of ore. Development work was carried on vigorously, not only in the lower levels but also in the upper levels. This work disclosed considerable new ore, but the grade continues to decline as it has done for some years past. A great portion of the developed ore is not of commercial grade. No exploration was done below the natural water level of the mine. It is intended to wait for developments above the water level before undertaking exploration below. Development work in the Bullion Beck and Champion property, operated by the Centennial-Eureka Mining Co., disclosed occasional bunches of ore, which, however, were not sufficient to pay all the cost of exploration.

The Eagle & Blue Bell Mining Co.[2] produced in 1913 from its mines 35,245 tons of ore, containing 7,514 ounces of gold, 417,279 ounces of silver, 4,639,073 pounds of lead, and 157,596 pounds of copper, valued in all at $515,324. The net returns were $304,915 after freight, smelting, assaying, and sampling costs were deducted.

The shipments and earnings show substantial increases over 1912, and the development work has fulfilled our predictions as to the extension of the Mammoth-Grand Central ore zone through the property. During the year ore was followed and developed through a winze to a depth of 190 feet below the 1,350 level. To facilitate the handling of this product and to explore to greater depth the No. 1, or main operating shaft, was sunk from the 1,350 to the 1,550-foot level. A station has since been cut and the 1,500-foot level is now being driven to connect with the ore developed through this winze. * * * Developments on the 700, 1,200, 1,300, 1,340, and 1,350 foot levels have been very gratifying, and near the close of the year a body of lead was encountered on the 1,000-foot level north of the shaft. * * * Total new work for the year consisted of 3,872 feet of drifts, crosscuts, winzes, and raises, costing $9.13 per foot, in addition to sinking the No. 1 shaft 205 feet.

The Colorado mine [3] yielded 3,231 tons of ore, which was shipped in 1913. This ore contained 309.28 ounces of gold, 102,406.45 ounces of silver, and 887,522 pounds of lead, valued in all at an average of $27.20 per ton. The low-grade siliceous ore developed in the Colorado property was formerly sold for converter lining, but is now reserved for the new milling plant which will be in operation at Silver City in 1914.

Ore mined and shipped through the Iron Blossom [4] No. 1 mine shaft in 1913 aggregated 22,902 tons, containing 3,902.30 ounces of gold, 666,619 ounces of silver, 3,188,474 pounds of lead, and 277,922 pounds of copper, valued in all at $24.76 per ton. From the No. 3 shaft 16,624 tons were handled and shipped, containing 3,387.16 ounces of gold, 688,773 ounces of silver, and 2,964,791 pounds of lead, valued in all at $32.82 per ton. The tonnage of ore from this property was not as large as in 1912, owing to the fact that none of the low-grade siliceous ores were moved pending the completion of the new mill belonging to the same interests. The mill is nearly completed and will operate in 1914. Extensive exploring has been conducted on the 1,900-foot level from the No. 1 shaft.

At the Lower Mammoth mine [5] development work was rather discouraging to the company in 1913.

In crosscutting east from the shaft on the 1800-foot level a very strong fissure was cut a width of 12 feet. It showed some copper stain, was very siliceous, and assayed in gold and silver about $4 per ton. Further development did not show improvement.

[1] United States Smelting & Refining Co., Eighth Ann. Rept. for year ending Dec. 31, 1913.
[2] Bingham Mines Co., Ann. Rept. for year ending Dec. 31, 1913.
[3] Colorado Mining Co., Ann. Rept. for year ending Nov. 1, 1913.
[4] Iron Blossom Consolidated Mining Co., Ann. Rept. for year ending Dec. 1, 1913.
[5] Lower Mammoth Mining Co., Ann. Rept. for year ending Dec. 31, 1913.

The same fissure on the 2,000-foot level was strong and the ore encountered was sulphide of a very low grade. Work was continued on the 1,800-foot level north as far as the old Gold Chain line and south from the crosscut about 150 feet. On our 1,500-foot level the ore yielded no profit and but one car was shipped. The Gold Chain Mining Co. is extending work in its own territory from our 1,800 and 1,500-foot levels. Some zinc ore of shipping grade remains in the mine, but shipments were discontinued when the price of zinc fell below 5.75 cents per pound. Much low-grade zinc ore was developed. There was shipped 806 tons of zinc oxidized ore, which gave net returns of $9,673. Of copper oxidized ore from the west fissure of the 1,000-foot level 101 tons gave net returns of $979. One lot of 69 tons of lead oxidized ore gave net returns of $89.

The Chief Consolidated mine[1], according to its annual printed report, produced 51,173 tons of shipping ore in 1913, yielding, after smelter, transportation, and sampling charges had been deducted, a net value of $376,827.08. This ore contained 4,751 ounces of gold, 1,017,107 ounces of silver, 2,584,857 pounds of lead, and 114,305 pounds of copper. The average gross value of the ore per ton was $16.29, the freight, smelting, and sampling charges, $8.92, and the average net value, $7.37. The mine is opened by a vertical shaft which reached water level at 1,800 feet. Dividends No. 1 and No. 2 were paid in 1913, amounting to $175,307.40.

West Tintic district.—The Scotia mine shipped a small quantity of carbonate lead ore carrying 40 per cent lead with silver and gold.

MILLARD COUNTY.

Leamington district.—The Yellowstone property was a shipper of 12 tons of lead ore mined some years ago. The ore carried lead and a little silver, with a trace of copper. The property is opened by an incline shaft 200 feet deep and has 450 feet of drifting.

MORGAN COUNTY.

Argenta district.—A small tonnage of oxidized lead ore was shipped from the Carbonate group in 1913.

PIUTE COUNTY.

Gold Mountain district.—The Annie Laurie property, operated by the owners of the Sevier Consolidated, produced an important tonnage of milling ore, which yielded, by the cyanide process, bullion containing gold and silver averaging gold 0.300 fine and silver 0.659 fine. Two other producers reported a small output of bullion.

Ohio district.—The Bully Boy & Webster, Wedge & Shamrock properties were operated, each producing during 1913. The Bully Boy Mining Co. completed its milling facilities, and concentrates carrying lead, silver, and gold, with a trace of copper, were shipped. Early in 1914 a cyanide plant was added to the equipment.

SALT LAKE COUNTY.

There were 51 producers, against 53 in 1912. The yield of ore aggregated 9,195,624 tons, 2,619,077 tons more than in 1912. The total average value per ton of the ore for the gold, silver, copper, lead, and zinc decreased from $3.75 in 1912 to $3.17 in 1913, and the gold and silver value of this ore from $0.48 to $0.36 per ton. The principal

[1] Chief Consolidated Mining Co., Ann. Rept. for year ending Dec. 31, 1913.

part of the output, consisting of the low-grade disseminated copper ores, was mined by steam shovels at Bingham and sent to the mills at Bingham, Lark, and Garfield for concentration, and aggregated 8,527,755 tons yielding 443,640 tons of concentrate, against 6,061,723 tons of ore and 308,039 tons of concentrate in 1912. Copper concentrates have formed the largest part of the product shipped each year beginning in 1908, and lesser quantities of lead and zinc made up the totals. The total value of the concentrate product in 1913 amounted to $21,977,911, or an average value of $49.54 per ton, as against a total value of $19,071,054 and an average value of $61.91 in 1912. Low-grade siliceous ores containing silver were treated by cyanidation at one milling plant.

Big and Little Cottonwood districts.—It has been impossible to show the combined production for these districts since 1870 to the present time, as the production statistics are only fragmentary and no long period of output is covered by former statisticians. The total production from 1870 including 1913 is approximately 20,492.81 ounces of gold, 14,002,000 ounces of silver, over 10,000,000 pounds of copper, and 151,838,000 pounds of lead. The table giving these totals by years is withheld in the hope of having more definite figures for a future report. The output between 1905 and 1913 is given in the following table:

Number of mines producing in Big and Little Cottonwood districts, and total tons of ore sold or treated in 1905–1913, and total output of gold, silver, and associated metals.

Year.	Number of producers.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	6	26,003	$19,638	371,683	811,639	1,702,258	$450,756
1906	10	20,801	15,753	345,102	1,193,743	1,922,276	586,933
1907	11	19,896	20,195	399,417	1,074,238	2,337,924	622,568
1908	21	5,866	6,643	63,246	269,212	603,840	101,061
1909	15	13,208	6,940	158,867	1,842,711	332,475	343,400
1910	17	14,203	7,894	202,010	804,018	1,102,907	267,617
1911	12	6,040	2,877	158,448	407,719	1,043,608	184,783
1912	15	6,566	2,945	186,183	386,963	1,135,191	232,381
1913	12	5,167	2,317	93,821	136,901	1,091,617	128,235
Decrease (−) in 1913	.....	−1,399	−628	−92,362	−250,062	−43,574	−104,146

A decrease was recorded in the production of all metals and in value from $232,381 in 1912 to $128,235 in 1913. The largest part of the decrease was in copper and silver, with a slightly lower output of lead. There were 1,399 tons of ore less shipped out of the camps, owing principally to the attention given to the extensive development carried on in 1913 and in preparation for the extension of the Alta tunnel from the Big Cottonwood side of the divide underneath the old bonanzas of Little Cottonwood. The tunnel will attain great depth upon several historic veins and carry off water that has heretofore troubled the operators. By the completion in November, 1914, of the Salt Lake & Alta Railroad from Sandy to Wasatch in Little Cottonwood Canyon, it is said that a saving will be made of at least $1.50 in the transportation cost of ore from Alta to the smelters, as the railroad reduces the wagon haul 9 miles. The principal producers in 1913 were the Michigan-Utah (Black Bess and City Rocks), Alta Consolidated, Columbus Consolidated, and South

Hecla, Cardiff, Albion, and Maxfield properties. Early in the year the Columbus was merged with the Flagstaff and Superior-Alta companies in the Wasatch Mines Co.

Smelter district.—A very small tonnage of old slag was reported in 1913 from the old smelter dumps.

West Mountain or Bingham district.—The first discovery [1] of mineral was made by George B. Ogilvie, who was engaged in farming. On September 17, 1863, the site of this discovery was formally located as the West Jordan claim by the discoverer and 24 others. The district was organized in December, 1863, being the first in the Territory. On July 31, 1869,[2] Woodhull Brothers made the first shipment of Utah copper ore, 10 tons, from the Kingston mine, Bingham Canyon. According to Bancroft,[3] however, the first shipment of ore from Utah was a carload of copper ore from Bingham Canyon, hauled to Uintah, on the Union Pacific, and forwarded by Walker Bros. to Baltimore in June, 1868. Other than this reported production, very little work was performed in the district beyond prospecting and locating claims on the ledges and deposits until the summer of 1870.[4] Placer gold [5] was discovered by a party of old Californians in the early part of 1864. In the spring of 1865 gravel washing was actively taken up. It is estimated that during the opening period of placer mining in this district up to 1871 about $1,000,000 was recovered from the gravels. Early in the fall of 1870 the first really efficient and practical development of the mines of this district was commenced by Messrs. Bristol and Daggett on the Spanish and Winamuck mines. A group of mines consisting of about nine claims known later, after their sale to an English company, as the Utah Silver Mining Co., was also successfully operated. In the summer of 1873 freight companies levied such high rates that shipping was temporarily abandoned, but the success attending the smelting operations of Messrs. Bristol, Daggett, and Buel more than offset this influence. In 1875 the Winamuck smelter shut down. By 1882 four stamp mills had been erected to work the oxidized gold ore, and later cyanide plants. In 1881 and in 1884 the Brooklyn, Lead, and Yosemite mines headed the list of producers of lead ore. In 1891 and 1892 among 21 producing mines, the Old Jordan & Galena, Brooklyn, Highland, Telegraph, York, Petro, and Yosemite were the leading producers.

Although sulphide copper ore had been known in Bingham for many years, it was not until December, 1896, when 5,000 tons were shipped in the course of developing the Highland Boy, that it was regarded as commercially valuable. In 1896 the Utah Consolidated Mining Co. solved the problem of working the low-grade copper ores by consolidating many small adjoining properties under single management and smelting its own ore, beginning in 1899 with a smelter of 250 tons daily capacity. In March, 1899, the United States Mining Co. purchased the Old Jordan & Galena, Utah, Niagara (Spanish), and Old Telegraph mines. The period from 1896 to 1900 was characterized by consolidation of large tracts of mining ground under individual companies. In 1903 and 1904 the Boston Consolidated and the Utah Copper Co. began the treatment of low-grade copper porphyry ores

[1] Boutwell, J. M., Economic geology of the Bingham district, Utah: U. S. Geol. Survey Prof. Paper 38, pp. 81, 83, 98, 1905.
[2] Sloan, E. L., Utah Gazetteer, 1874. See Utah chronology.
[3] Bancroft, H. H., History of Utah, p. 741.
[4] Murphy, J. R., Mineral Resources of the Territory of Utah, p. 15, 1872.
[5] Boutwell, J. M., loc. cit.

by concentration. These companies were consolidated in 1910, and in 1913 the Utah Copper Co. was treating an average of 21,000 tons of copper ore daily at its two concentration mills near Garfield, Utah.

From 1865 to and including 1913 there is credited to Bingham $21,927,888 in gold, $28,129,837 in silver, $130,387,778 in copper, $33,430,796 in lead, and $875,487 in zinc, and a total gross value of $214,751,786, out of which dividends (partly estimated) were paid amounting to $28,617,046.

Quantity of ore sold or treated in West Mountain or Bingham district in 1865–1913, number of mines producing, and total output of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.[a]
		Short tons.	*Value.*	*Fine ounces.*	*Tons.*	*Tons.*	*Tons.*	
1865–1872[b]			$896,641	712,212	20	3,699		$2,316,954
1873			[c] 2,699	[d] 495,000	[d] 25	[e] 3,280		1,053,799
1874			[c] 84,982	[d] 416,920	[d] 60	[e] 2,000		885,040
1875			[c] 29,995	[d] 300,000	[d] 200	[c e] 13,500		2,058,795
1876			[d] 37,209	[d] 435,000	[d] 268	[f] 13,000		2,240,369
1877			[g] 77,519	[d] 550,000	[d] 114	[f] 10,500		1,935,839
1878			[g] 62,016	[d] 650,000	[d] 267	[d] 7,535		1,440,746
1879			[g] 82,687	[h] 950,000	[d] 50	[d] 4,230		1,512,147
1880			[g] 153,178	[d] 430,965	[d] 25	[d] 4,471		1,106,623
1881			[g] 89,240	[d] 805,193	[d] 23	[d] 6,173		1,599,892
1882			[c] 69,995	[c] 433,134	[d] 25	[d] 4,250		989,833
1883			[c] 65,597	[c] 439,981	[d] 25	[d] 8,125		1,260,971
1884			[c] 103,359	[d] 440,590	[d] 48	[i] 7,675		1,172,718
1885			[c] 103,359	[c] 1,350,000	[d] 50	[d] 7,125		2,114,409
1886			[c] 103,359	[c] 800,000	[d] 120	[d] 10,000		1,841,999
1887			[c] 90,956	[c] 600,000	[d] 250	[d] 9,000		1,557,956
1888			[c] 72,351	[c] 483,000	[d] 325	[d] 9,000		1,427,571
1889			[c] 97,261	[c] 561,280	[d] 125	[d] 8,794		1,344,641
1890			[c] 83,452	[c] 450,990	[d] 88	[d] 8,601		1,358,382
1891			[c] 135,690	[c] 750,500	[d] 297	[d] 13,282		2,097,005
1892			[c] 96,000	[c] 605,896	[d] 249	[d] 12,253		1,661,002
1893			[c] 165,375	[c] 650,000	[d] 103	[d] 10,021		1,436,073
1894			[c] 227,390	[c] 650,000	[d] 137	[d] 7,125		1,133,242
1895			[c] 206,718	[c] 700,000	[d] 305	[d] 7,921		1,234,018
1896			[c] 165,375	[c] 610,000	[d] 250	[d] 7,771		1,100,444
1897			[c] 148,837	[c] 500,000	[d] 709	[d] 5,728		1,031,562
1898			[c] 186,047	[c] 350,000	[d] 1,142	[d] 2,860		893,097
1899			[c] 178,005	[c] 201,801	[c j] 2,073	[c] 1,160		1,112,286
1900			[c] 252,734	[c] 238,267	[c] 3,098	[c] 2,130		1,616,546
1901			[d] 356,837	[d] 415,154	[d] 7,211	[d] 1,377		3,132,918
1902			[k] 549,457	[k] 249,264	[k] 7,880	[k] 1,948		2,763,995
1903			[k] 892,858	[k] 470,077	[k] 8,640	[k] 1,121		3,608,167
1904			[k] 1,165,685	[k] 1,440,213	[k] 15,314	[k] 2,602		6,046,513
1905	21	[k] 1,012,009	[k] 1,316,817	[k] 1,980,583	[k] 19,609	[k] 11,747		9,735,627
1905	25	[k] 996,121	[k] 1,632,786	[k] 1,927,350	[k] 19,712	[k] 11,464		11,839,873
1907	29	[k] 1,503,082	[k] 1,565,483	[k] 1,786,580	[k] 22,716	[k] 10,986		12,995,485
1908	27	[k] 2,691,640	[k] 1,248,221	[k] 1,053,146	[k] 35,578	[k] 7,585		11,836,067
1909	24	[k] 4,166,992	[k] 1,521,436	[k] 1,615,394	[k] 46,280	[k] 15,183	325	15,735,090
1910	31	[k] 5,427,953	[k] 1,767,992	[k] 1,800,410	[k] 56,863	[k] 15,136	1,786	18,708,156
1911	32	[k] 6,044,893	[k] 2,281,943	[k] 2,786,810	[k] 64,998	[k] 23,288	2,357	22,373,132
1912	32	[k] 6,567,948	[k] 1,785,532	[k] 2,028,496	[k] 58,311	[k] 21,911	[k] 1,356	24,434,792
1913	35	[k] 9,190,374	[k] 1,774,815	[k] 2,408,692	[k] 72,460	[k] 35,500	[k] 1,711	29,008,007
Total			21,927,888	36,522,898	446,043	371,057	7,535	214,751,781

[a] Average commercial prices used for each metal to make total for each calendar year.

[b] In 1864 placers discovered and in 1865 gravel washing actively taken up. * * * Estimated up to 1871 about $1,000,000 in gold produced. * * * First shipment of ore in Utah was a carload of copper ore from Bingham in June, 1868. See U. S. Geol. Survey Prof. Paper 38, p. 83.

[c] U. S. Geol. Survey Prof. Paper 38, p. 97, 1905.

[d] Estimated by V. C. Heikes from a separation of the total output reported by the Director of the Mint or given in the annual reviews of the Salt Lake Tribune and U. S. Geol. Survey Mineral Resources, 1882–1897. Part of the records of some early producers were used in the estimates.

[e] Winnamuck mine largest producer of lead ore starts heavy output in 1872.

[f] Old Telegraph mine principal producer.

[g] Salt Lake Tribune, Jan. 1, 1878.

[h] U. S. Geol. Survey Sixteenth Ann. Rept., pt. 2, pp. 354–357, 1894–95.

[i] U. S. Geol. Survey Mineral Resources, p. 417, 1874.

[j] Highland Boy mine starts with heavy output.

[k] U. S. Geol. Survey Mineral Resources, 1902–1913.

[l] Utah Copper Co. begins production.

In 1913 the output of ore aggregated 9,190,374 tons, against 6,567,948 tons in 1912, and 6,044,893 tons in 1911. The total value of recoverable metals in the ores in 1913 was $29,008,007, or an average recovery value of $3.16 per ton, against an output valued at $24,434,792, or an average of $3.72 per ton, in 1912. The gold output decreased slightly from $1,785,532 in 1912 to $1,774,815 in 1913. Silver increased, amounting in value to $1,454,850 in 1913, as against $1,247,525 in 1912. The copper production increased in total value from $19,242,596 in 1912 to $22,462,676 in 1913, and lead from $1,972,012 in 1912 to $3,124,050 in 1913, also zinc from $187,127 in 1912 to $191,616 in 1913. The shipments of ore to the smelters in 1913 aggregated 655,634 tons, against 502,682 tons in 1912 and 661,852 tons in 1911. The concentrating ores aggregated 8,527,755 tons, against 6,060,018 tons in 1912 and 5,369,388 tons in 1911. Concentrates produced were 443,640 tons in 1913, against 307,613 tons in 1912 and 271,932 tons in 1911. The crude smelting ore consisted principally of low-grade copper and lead sulphides and contained 48,753.75 ounces of gold, 1,556,156 ounces of silver, 19,304,012 pounds of copper, and 46,377,559 pounds of lead, valued in all at $6,980,483, or an average value of $10.65 per ton. The milling ores, yielding 443,640 tons of copper, lead, and zinc concentrates, contained 36,061.61 ounces of gold, 806,031 ounces of silver, 125,616,482 pounds of copper, 24,623,579 pounds of lead, and 3,421,724 pounds of zinc, valued in all at $21,977,912, or an average value of $49.54 per ton. Silver-gold bullion extracted from siliceous ores mined from the Telegraph mine were treated in the cyanide mill of the Utah Leasing Co. The number of mines and different kinds of ore produced in 1913 are given in the following table:

Output of ore and production of metals in Bingham district, Utah, in 1913, by kinds of ore.

Kind of ore.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Siliceous	3	7,703	1,308.93	51,350	14,751	17,575	.....
Copper	14	8,801,551	68,784.24	1,039,358	141,460,150	20,302	94,564
Lead	28	300,742	11,456.26	1,074,839	3,038,410	60,556,249	25,203
Copper-lead	1	16	1.74	749	1,850	3,046	.....
Lead-zinc	11	80,362	4,305.48	242,396	405,333	10,403,966	3,301,371
Total	[a] 57	9,190,374	85,856.65	2,408,692	144,920,494	71,001,138	3,421,138

[a] There were only 35 producing mines, but more than one kind of ore was mined at several of them.

From steam-shovel operations at the Utah Copper property and some underground mining in the Boston group of the Utah Copper Co., 7,519,392 dry tons of low-grade copper ore were shipped to the two mills of the company near Garfield and there concentrated. The gross productions of copper in concentrates was 119,939,809 pounds. After making smelter deductions, a net production of 113,942,834 pounds of refined copper was obtained. In addition there were produced 28,121.24 ounces of gold and 285,589 ounces of silver. The sales and deliveries of copper for the year were made at a gross price

of 15.33 cents per pound. The net operating profit from Utah mining operations for 1913 amounted to $6,303,223.29.

Dividends for the same period, amounted to $4,747,710, including those from Nevada holdings.[1] At the close of the year 1912, the total ore-bearing area fully and partially developed was 217.26 acres. During the year 1913, this area was increased to 225.31 acres, and the calculated average thickness of developed and partially developed ore was increased from 424.3 feet to 444.5 feet. A revised estimate of the ore reserves was made, taking into account the additional development work done during the year, and this shows that previous to January 1, 1914, there had been developed in the entire property 361,220,234 tons of ore, of which quantity 268,000,000 tons are classed as fully developed, and 93,220,234 tons as partially developed. This tonnage includes 28,700,000 tons of partially developed ore in the slopes of the steam-shovel workings. * * * The average assay of the fully developed ore is 1.59 per cent copper, and the average assay of the partially developed ore is 1.15 per cent copper, making the average assay of both classes of ore 1.47 per cent. There was mined from the entire property prior to January 1, 1914, a total of 28,720,234 tons of ore, averaging 1.465 per cent copper, and the total reserves remaining, therefore, amount to 332,500,000 tons averaging 1.47 per cent copper. In making the calculations to determine the average assay of the ore reserves, there were used 50,761 assays, representing 23,465 feet of diamond drill and churn drill holes, 285,913 feet of drifts, raises, and winzes, and 7,130 linear feet of steam-shovel cuts, or a total of 316,508 linear feet of development work. * * * Underground mining operations were continued in the original Boston area throughout the year, but will be abandoned not later than May 1, 1914, at which time all necessary underground development in that part of the property will be completed; and thereafter it is probable that all development will be done by drilling. Of the total ore mined during 1913, 91.02 per cent was produced by steam shovels and 8.98 per cent was mined underground, as compared with 77.81 per cent and 22.19 per cent, respectively, for the previous year. The average cost of steam-shovel mining for the year was 29.26 cents per ton, of which 8.32 cents represents charges on account of stripping expense and prospecting, leaving an actual working cost, including the proper proportionment of all extraordinary and general charges, of 20.94 cents per ton, as compared with 26.35 cents for the year 1912. The average cost of underground mining for the year was 69.52 cents per ton, of which 17.72 cents represents the cost of underground development, as compared with 67.39 cents and 15.62 cents, respectively, for the previous year. During the year, the combined average cost of surface and underground mining was 32.88 cents per ton, of which amount 9.84 cents were charged to cover prospecting with churn drills, underground development, and the fixed charge of 7½ cents per ton for stripping expense, leaving the net working cost for producing all ore, including general and fixed charges, 23.04 cents per ton, as compared with 42.33 cents total, 12.01 cents development, etc., and 30.32 cents direct cost for the year 1912. * * * During 1913, there were milled at the Magna plant 4,142,700 tons of ore, an increase of 687,900 tons as compared with the previous year; while at the Arthur Plant, 3,376,692 tons were milled, the increase being 1,516,171 tons over the year before. The total ore treated at both plants was 7,519,392 tons, as compared with 5,315,321 tons for 1912. During the year, when running on low-grade ore, the Magna plant demonstrated its ability to handle nearly 14,000 tons daily and the Arthur plant over 10,000 tons daily, making the capacity of both plants, when treating such material, about 24,000 tons per day. * * * The average grade of ore milled at both plants for the year was a trifle under 1.25 per cent copper, as compared with 1.36 per cent for 1912. This decrease was due to mining a large percentage of the ore from the low-grade area near the northerly limit of the deposit. * * * The average recovery for the year at the Magna plant was 63.78 per cent and at the Arthur plant 64.18 per cent. The average recovery at both plants was 63.95 per cent, corresponding to 15.95 pounds of copper per ton, as compared to 66.32 per cent, or 18.09 pounds of copper per ton, for the previous year. The decreased percentage of recovery was due to the lower average grade of the ore milled, and the consequent necessity of crowding the capacity of the mills to high tonnages, in order to maintain a fairly constant production from the property while treating such low grade ore. * * * The cost of milling at Magna was 35.59 cents, and at Arthur 38.20 cents per ton, as compared with 39.64 cents and 45.18 cents, respectively for the year 1912. The average cost of milling at both plants was 36.76 cents per ton, as compared to 41.58 cents for the previous year. * * * The total gross production of copper contained in concentrates was 119,939,809 pounds as compared to 96,175,090

[1] Utah Copper Co., Ann. Rept. for year ending Dec. 31, 1913.

pounds for the year 1912. The concentrates produced averaged 17.31 per cent copper, as compared to 20.75 per cent for the previous year. This decrease in grade of concentrates was due partly to the character of the underground ores which came from an area containing a higher percentage of iron than the average of the mine, and partly to ores from the low-grade area of the deposit. * * * The net value of the gold and silver recovered amounted to 0.643 cents per pound, as compared with 0.957 cents for 1912. This decrease was to be expected in connection with the lower grade ore treated. * * * The average costs for the year of mining, transportation, and milling per dry ton of ore, as compared with the years 1910, 1911, and 1912, are as follows:

Average cost per ton of ore of mining, transportation, and milling in Boston group of Utah Copper Co., 1910–1913.

Year.	Tonnage.	Mining.	Transportation.	Milling.	Total.
1910	4,340,245	$0.4097	$0.2978	$0.4663	$1.1738
1911	4,680,801	.4479	.3078	.4168	1.1725
1912	5,315,321	.4233	.2848	.4158	1.1239
1913	7,519,392	.3288	.2797	.3676	0.9761

In 1913 the Highland Boy mine [1] produced 7,710,668 pounds of copper, 19,208,063 pounds of lead, 378,960 ounces of silver, and 14,172 ounces of gold. There was mined and shipped to the International smelter over the company's aerial tramway ore classified as follows:

Average assay per ton of crude ore shipped from the Highland Boy mine in Utah in 1913.

Kind of material.	Dry ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Per cent.*	*Per cent.*
Copper iron sulphide ore	181,077	0.056	0.705	1.980	.....
Lead sulphide ore	70,889	0.060	3.922	0.968	15.053

The profits for the year were $630,828.86. * * * During the year 20,510 feet of exploration and development work was done and was carried on mainly in these directions:

In the western portion of the Upper limestone, which overlies the Highland Boy lime. The most important and successful work was done in this part of the property. The ore here developed is lead and makes on the contact between the limestone and quartzite. It was found to be continuous from the California to the No. 5 level, a distance of 570 feet on the dip, while its greatest length is on the No. 5 level where the ore shoot is 500 feet long, with an average width of 4.8 feet and an average assay of 0.9 per cent of copper, 18.7 per cent of lead, 0.06 ounce of gold, and 3.07 ounces of silver. Below the No. 5 level a 45-foot winze was sunk in ore with the bottom still in ore; and on the No. 7 level, 600 feet lower down on the dip, a 1,500-foot crosscut is being driven to cut the contact.

Developing copper ore above the porphyry dike on Nos. 10, 11, and 12 levels. Here 190,000 tons of ore, assaying 1.75 per cent copper, was opened up, but being high in silica if can not now be worked at a profit and has not been included in the ore reserves. Tests by an oil flotation process are being carried on with a view to making a commercial concentrate from this and other low-grade copper ore bodies in the mine. So far returns from these tests are indecisive.

In 1913 the Ohio Copper Co. handled at its mill at Lark an average of about 65,000 tons of low-grade disseminated copper ore per month.

[1] Utah Consolidated Mining Co., Ann. Rept. for year ending Dec. 31, 1913.

It is reported that the cost of developing and mining the ore is from 21 to 23 cents per ton. To this is added 15 cents per ton for transportation to the ore bins. Milling costs are about 45 to 47 cents per ton. The mine is developed by a main shaft, an incline 1,397 feet deep, and by the Mascotte tunnel 14,000 feet in length. This tunnel, which has its portal at Lark, connects the bottom of the main working shaft with the company's mill. Through this tunnel, equipped with double track and electric haulage, all ore is transported to the concentrator.

The Old Jordan, Galena, and Telegraph groups [1] of the United States Mining Co. produced 78,165 tons of lead ores and 123,757 tons of copper ores. The usual amount of exploration work was carried on in these mines. In 1913 the adjoining property, the Last Chance group of claims, was purchased.

Both the Dalton-Lark and the Commercial mines [2] worked under adverse labor conditions during the forepart of 1913, as a result of the 1912 strike of miners.

This hampered and delayed the development work for several months and resulted in greatly decreasing the ore reserves. As conditions improved, the development work was crowded, and has since kept ahead of mining. The 1913 output from the Dalton & Lark mine is slightly less than that of 1912, and the ore somewhat lower grade. The decrease in metal prices as compared with the previous year also tended to reduce the earnings. The Lead mine lead body which furnished a large and profitable tonnage in past years was exhausted in May. Most of the lead shipments have since come from the Brooklyn, where the lead is found in bunches in the large bodies of low-grade copper ore which have been developed through No. 5, No. 6, and No. 9, raises from the Mascotte tunnel level. More than two-thirds of the shipments now consist of copper ore, on which there is only a small margin of profit. The Commercial mine was shut down as usual during the months of June, July, August, and a part of September, on account of foul air. The 1913 shipments from the Commercial mine are materially less than in 1912, principally due to the fact that shipping ore was not developed below the 500-foot level.

The Dalton & Lark mine produced 7,539.74 tons of lead ore and 22,517.37 tons of copper ore, and the Commercial mine 8,930.82 tons of copper sulphide ore. The total ore produced, 38,987.95 dry tons, contained 2,995 ounces of gold, 179,117 ounces of silver, 2,745,818 pounds of lead, and 1,122,955 pounds of copper, valued in all at $299,138.25.

From the old custom workings of the Yosemite mine [2] lessees shipped 623 tons of lead sulphide ore. This mine is under development through the Mascotte tunnel level, from which a raise 1,066 feet in length connected it with an inclined shaft of the Yosemite mine.

The Utah Apex mine [3] shipped sulphide ores containing gold, silver, copper, lead, and zinc having a gross value of $803,928.

The labor strike in Bingham camp, referred to in our report for 1912, proved more disastrous than anticipated, extending for a period of several months and necessitating the complete closing of the mine and mill. * * * We have also been considerably handicapped during the year in the treatment of our ores by the smelters. For a very short period we were shipping at the rate of 400 tons but obliged suddenly to reduce the output to 100 tons, later increasing to 300 tons and at the present time (October, 1913) down again to 100 tons.

[1] United States Smelting & Refining Co. Eighth Ann. Rept. for year ending Dec. 31, 1913.
[2] Bingham Mines Co., Fifth Ann. Rept. for year ending Dec. 31, 1913.
[3] Utah Apex Mining Co., Ann. Rept. for year ending Aug. 31, 1913.

The Utah Metal [1] tunnel was begun in December, 1909, and finished June 22, 1913. It is 11,494 feet in length from the Bingham side to the Middle Canyon or Tooele side of West Mountain. The company has a daily flow of about 750,000 gallons of water, of which 440,000 gallons are delivered to the Utah Copper Co. for use in its steam boilers. Other mines are also getting a supply of water through this tunnel which will likely be used for hauling waste and mill tailings to dump in Middle Canyon, as space for dumping is scarce in Bingham. The tunnel company is developing mineral ground from the 9,100-foot point in the tunnel toward the Bingham and New Haven mine.

SEVIER COUNTY.

No production was recorded in any of the districts of the county in 1913. The mill of the Sevier Consolidated property was operated on Annie Laurie gold ores mined in the Gold Mountain district, which has its greatest area in Piute County.

SUMMIT COUNTY AND WASATCH COUNTY.

The Park City region, formerly known as the Parley's Park district,[2] was organized in July, 1868. It embraced the Uintah, Howland, and Blue Ledge districts. The Howland was cut off from it in the spring of 1872, and the Blue Ledge district was organized in the same year. The principal mines in the Uintah district [3] in 1872 were the Pinyon, Walker & Webster, also the Bobtail and the Central. The principal mines in the Howland district were the Flagstaff, Wild Bill, and Rocky Bar. In the spring of 1872 the McHenry discovery was made in the Blue Ledge district and created at the time some excitement on account of the extensive croppings of rich milling ore. About the same time the Ontario was located, and still later the Dolly Varden, Highland Jennie, and Cariboo, all high-grade galena ores assaying well from the surface. The Snake Creek mining district was organized in the fall of 1870. The principal claims in 1872 were the Beckwith, Ohio, Snow Squall, Silver Chief, and Howland. About 1,500 tons [2] of ore had been shipped to the market up to the end of the year 1874. In the following table the figures have been partly estimated, but show very closely the production of the Park City mining region by years between 1870 and 1913. During this period it is estimated that the gross value of the metallic output was $149,091,370, out of which $38,753,126 was paid in dividends. The metals to make the total given, figured at average commercial prices for each year, were valued at $3,959,132 in gold, $70,601,175 in silver, $21,673,793 in copper, $26,671,505 in lead, and $457,378 in zinc.

ERRATUM.

Page 404, last two lines of text should read $91,336,065 in silver, $3,587,247 in copper, $47,602,156 in lead, and $2,606,770 in zinc.

Quantity of ore sold or treated in Park City mining region in 1870–1913, number of mines producing, and total output of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.[a]
		Short tons.	*Value.*	*Fine ounces.*	*Tons.*	*Tons.*	*Tons.*	
1870–1875[b]				[c] 651,300		[c] 1,232		$982,217
1876				[c] 850,000		[c] 750		1,077,502
1877				[d] 1,310,145		[c] 900		1,671,174
1878				[d] 1,112,030		[c] 875		1,341,835
1879				[d] 1,041,771		[c] 750		1,228,284
1880				[c] 1,252,470		[c] 1,470		1,587,341
1881			[d] $703	[d] 1,931,089		[c] 5,037		2,666,386
1882				[c] 1,934,984		[c] 5,250		2,720,382
1883			[d] 17,530	[d] 2,011,691		[c e] 7,363		2,883,682
1884			[c] 14,987	[c] 2,167,182		[c] 6,165		2,876,754
1885			[d] 45,933	[d] 3,126,890		[c] 8,000		4,015,705
1886			[d] 47,235	[d] 2,881,436		[c] 7,500		3,589,857
1887			[d] 40,496	[d] 3,159,453		[c] 7,044		3,770,720
1888			[d] 52,941	[d] 3,398,126		[c] 7,500		3,907,179
1889			[d] 86,222	[d] 3,800,266		[c] 9,681		4,413,590
1890			[d] 63,152	[d] 3,120,063		[c] 9,167		4,164,257
1891			[d] 71,318	[d] 3,865,510		[c] 11,993		4,929,554
1892			[d] 98,605	[d] 4,078,238		[c] 14,574		4,812,592
1893			[d] 59,432	[d] 2,709,672		[c] 12,586		3,104,355
1894			[d] 92,010	[d] 2,802,289		[c] 8,377		2,410,335
1895			[d] 85,436	[d] 3,204,004		[c] 8,738		2,727,239
1896			[d] 90,471	[d] 3,134,820		[c] 14,159		3,071,701
1897			[d] 107,494	[d] 2,737,268		[c] 16,381		2,929,301
1898			[d] 133,106	[d] 2,215,496	[d] 27	[d] 18,617		2,776,361
1899			[d] 181,974	[d] 3,152,329	[d] 403	[d] 20,942		4,095,899
1900			[d] 187,969	[d] 3,931,205	[d] 352	[d] 23,491		4,809,311
1901			[d] 283,845	[d] 7,060,623	[d] 1,239	[d] 39,116		7,605,373
1902			[f] 311,793	[f] 7,990,200	[f] 1,435	[f] 34,917		7,759,844
1903			[f] 316,631	[f] 7,109,209	[f] 1,648	[f] 39,122		7,893,543
1904			[f] 282,001	[f] 5,814,386	[f] 1,059	[f] 32,156		6,689,215
1905	14	[f] 228,142	[f] 306,088	[f] 3,998,165	[f] 627	[f] 22,640	[f] 986	5,161,192
1906	14	[f] 264,792	[f] 245,678	[f] 3,755,339	[f] 597	[f] 23,256	[f] 1,759	5,857,983
1907	15	[f] 235,628	[f] 173,923	[f] 2,794,552	[f] 473	[f] 18,117	[f] 129	4,143,181
1908	11	[f] 142,331	[f] 105,082	[f] 2,463,735	[f] 270	[f] 17,026	[f] 703	2,978,518
1909	18	[f] 196,172	[f] 99,518	[f] 2,825,385	[f] 828	[f] 23,175	[f] 3,369	4,140,844
1910	16	[f] 215,339	[f] 92,351	[f] 2,571,771	[f] 712	[f] 19,065	[f] 4,719	3,849,268
1911	22	[f] 296,350	[f] 102,204	[f] 3,428,651	[f] 641	[f] 23,819	[f] 4,298	4,713,236
1912	18	[f] 280,671	[f] 75,748	[f] 3,642,749	[f] 984	[f] 21,056	[f] 4,001	5,087,924
1913	17	[f] 270,527	[f] 87,256	[f] 3,717,556	[f] 897	[f] 20,904	[f] 2,490	4,729,232
Total			3,959,132	122,752,048	12,192	551,911	22,454	149,091,370

[a] Average commercial prices used for each metal to make total for each calendar year.
[b] In 1870–71 the Flagstaff, Pinyon, Pioneer, Buckeye, Walker & Webster, Wild Bill, and Rocky Bar were discovered and were producers with the Ontario, discovered in 1872. The latter produced shipping ore in 1873 and 1874 and up to December, 1876, had yielded $1,100,000. See U. S. Geol. Survey Prof. Paper 77, pp. 136–137, 1912.
[c] Estimated by V. C. Heikes from a separation of the total output reported by the Director of the Mint or given in the annual reviews of the Salt Lake Tribune and the U. S. Geol. Survey Mineral Resources, 1882–1897. Part of the records of some early producers were used in the estimates.
[d] U. S. Geol. Survey Prof. Paper 77, p. 36, 1912.
[e] Crescent and Sampson heaviest shippers of lead ores.
[f] U. S. Geol. Survey Mineral Resources, 1902–1913.

In 1913 there were produced from mines in the Park City region 270,527 tons of ore against a production of 280,671 tons in 1912 and of 296,350 tons in 1911. The crude ore shipped directly to the smelters consisted of mixed lead carbonates and sulphides and aggregated 35,587 tons, containing 2,465.24 ounces of gold, 2,051,769 ounces of silver, 1,157,514 pounds of copper, and 20,507,027 pounds of lead valued in all at $2,371,953, or an average value of $66.65 per ton. The remainder of the ore mined aggregated 188,814 tons, and was milled the bulk of it yielding 41,970 tons of concentrates (including concentrates from 17,657 tons of creek tailings) which contained 1,706.29 ounces of gold 1,472,273 ounces of silver, 619,208 pounds of copper, 21,279,300 pounds of lead, and 4,980,206 pounds of zinc (spelter), valued in all at $2,235,683, or an average value of $53.27 per

ton. In 1912 the average value of the shipping ore was $61.73 per ton and of concentrates $60.08 per ton.

The Silver King Coalition property in 1913 yielded the largest quantity of lead-silver ore of milling and shipping grade in the district. About one-third of the shipping ores were sulphides The total ore product,[1] which sold for $1,086,183.41, was as follows:

Production of Silver King Coalition property in 1913.

Kind of material.	Dry ore.	Gold.		Silver.		Lead.	
		Total.	Per ton.	Total.	Per ton.	Total.	Per ton.
	Short tons.	*Ounces.*	*Ounces.*	*Ounces.*	*Ounces.*	*Pounds.*	*Per cent.*
Crude ore	14,992	1,049	0.0699	999,166	66.64	11,113,432	37.06
Concentrates	[a] 8,916	678	.0760	424,954	47.66	5,215,694	29.24
Total	23,908	1,727	.....	1,424,120	.....	16,329,126	.....

[a] Produced from 54,837 tons of second-class ore, or a ratio of concentration of 6.14 tons into 1.

In the western part of the Silver King Coalition acreage of mineral ground development is being carried on in the Alliance tunnel adit at a point of 8,500 feet from its portal. On May 23, 1914 the new hoist and compressors were in operation and the shaft had been sunk 370 feet. The collar of this shaft is about 1,600 feet from the surface and it is proposed to sink 1,000 feet to reach the ore zone.

The Daly West mine [2] in 1913 produced 60,788 dry tons of crude ore of which 1,555 tons was first-class lead sulphide shipped directly to the smelters; 3,483 tons of lead-zinc ore went to outside smelting plants and 59,233 tons of low-grade lead-zinc ore was milled at the Daly West concentration mill. Of the first-class ore, 730 tons came from the 1,008-foot level, 425 tons from the 1,700-foot level, and 400 tons from the 900-foot level. The larger part of the mill ore, 41,463 tons in quantity, was mined from the 1,700-foot level; and 8,885 tons came from the 900-foot level; 4,742 tons from the 1,800-foot level; and 4,143 tons from the 1,550-foot level. A large body of ore is reported to have been opened on the 2,000-foot level, with exploratory work continuing on the 2,100-foot or deepest level. December 28, 1913, the main mill and hoist were totally destroyed. Both plants are to be rebuilt. The quantity and content of ore shipped and of products from milled ore were as follows:

Average assay of mill ore, crude ore, and concentrates treated and shipped by the Daly West Mining Co., Utah, in 1913.

Kind of material.	Dry ore.	Gold (per ton).	Silver (per ton).	Copper.	Lead.	Zinc.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Per cent.*	*Per cent.*	*Per cent.*
Ore treated at mills	59,233	.....	7.70	.....	5.00	4.30
Crude ore shipped	5,038	0.0398	52.61	1.86	20.06	.....
Lead concentrates shipped	8,332	.0342	40.01	1.03	34.54	.....
Zinc concentrates shipped	1,598	.....	19.27	.....	4.83	35.37

[1] Silver King Coalition Mines Co., Ann. Rept. for year ending Apr. 30, 1914.
[2] Daly West Mining Co., Ann. Rept. for year ending Dec. 31, 1913.

The Daly Judge mine [1] produced 53,897 dry tons of ore, of which 48,943 tons were concentrated at its mill, making 11,909 tons of lead sulphide concentrates and 3,719 tons of zinc sulphide concentrates. There were 4,954 tons of lead sulphide ore shipped to the smelters. The larger part of the ore of shipping grade came from the 1,200-foot level of the "back vein," and the next largest quantity from the 900-foot level of the "Daly vein." These two points in the mine also yielded the largest quantities of mill ore. During 1913 the top slicing system was adopted throughout for mining the "Daly vein" ore bodies, in all of which the ground is exceedingly heavy, often carrying water. All drifts and raises are run in the footwall. The mine is operated through an adit tunnel 6,600 feet long and a vertical shaft 1,600 feet deep. The tunnel cuts the shaft at its 1,200-foot station, and serves as the outlet for all ore to the shipping bins in Empire Canyon, near Park City. Waste is hoisted to the collar of the shaft. Levels are extended from eight shaft stations, inclusive of the station at 1,600 feet below the shaft collar. Three levels have been extended from the Daly West into the Daly Judge property, corresponding to the Daly Judge 1,900-foot level, 2,100-foot level, and 2,300-foot level. When completed, the Snake Creek Tunnel will serve as an outlet and drainage channel for the southwest portion of the property. The Snake Creek Tunnel was driven 370 feet in May, 1914, and at that time its face was 8,000 feet without a bend from its portal. The face of the tunnel is 2,300 feet from the surface and will be driven an additional 6,000 feet into the mountain. The first stringer of galena ore was cut by this tunnel during May. The quantity and content of the ore shipped and of products from ore milled were as follows:

Average metallic content of crude ore and concentrates of Daly Judge Mining Co., Utah, in 1913.

Kind of material.	Dry ore.	Gold (per ton).	Silver (per ton).	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Per cent.*	*Per cent.*	*Per cent.*
Crude ore shipped	4,954	0.036	38.29	1.86	21.72	14.28
Lead concentrates shipped	11,909	.032	29.10	1.08	27.85	13.85
Zinc middlings shipped	3,719	.617	20.04	.....	4.61	38.22

Production of ore commenced in November at the Silver King Consolidated [2] from the 1,500-foot level, on which development work was started adjacent to the shaft in the mineralized zone. Both first and second class ores were mined, and of the former 1,011 tons were marketed in the company's fiscal year, having a gross value of $41.34 per ton in silver, lead, and small quantities of gold and copper. The shaft was sunk from the 1,300-foot to the 1,800-foot level in 1913.

The Ontario mine [3] produced 1,184 tons of ore mined and shipped by the company, for which it received $16,359.65. In addition, a large quantity of mill ore was handled, most of which was left in the stopes. All of this production came from opening and prospecting three stopes above the 1,500-foot or drain tunnel, No. 2 level. Oper-

[1] Daly Judge Mining Co., Ann. Rept. for year ending Dec. 31, 1913.
[2] Silver King Consolidated Mining Co., Ann. Rept. for year ending Feb. 1, 1914.
[3] Ontario Silver Mining Co., Ann. Rept. for year ending Dec. 31, 1913.

ations of the Mines Operating Co.[2] owning a lease on a certain portion of the Ontario mine above the 900-foot level, treated an important tonnage of the fillings in the old Ontario mill.

The mill was at one time a chloridizing and leaching plant, and was subsequently converted into a concentrator. The plant had been idle for several years when it was leased by this company and remodeled to treat the stope fillings in the Ontario mine. The lease on the Ontario property is from the surface down to the 900-foot level. The old stopes are mostly in this leased area and filled with material that runs from 6 to 14 ounces silver, with very small amounts of gold, copper, and lead. The ore is hoisted in skips and dumped into an ore bin above the crusher. It is fed out of this ore bin by means of a Stephens-Adamson apron feeder, into a trommel having 1½-inch openings. The undersize from the trommel goes to a drier, where the moisture is reduced to 6 or 7 per cent. The oversize goes to a picking belt, where the mine wood and some waste are picked off and conveyed to a waste dump. The ore from the picking belt goes to a No. 5 Gates gyratory crusher. The discharge from the crusher, and the discharge from the drier, meet on a belt conveyor and are taken to an elevator which raises the ore to the crushed ore storage bin. This bin is divided into three compartments for ore, salt, and coal, respectively. Feeders out of each compartment discharge the various materials upon a belt conveyor, in the proper proportions, thus mixing the coal and salt with the ore. At present about 7 per cent of salt and 2.5 per cent coal are used. The prepared ore is crushed in two sets of 15 by 36-inch rolls, so that most of it will pass a ⅜-inch screen. The crushed ore is discharged into a bin above the roasters and from this bin it is charged directly into the roasters by means of chutes. The roasters are of an entirely new type, covered by the Buddeus and Christensen & Holt patents, consisting of a shaft blast roaster, with the zone of combustion traveling through a column of suitably prepared ore. By means of this roasting process a perfect chloridizing roast is gained without loss from volatilization or dust, and at a remarkably low cost. These roasters have been in operation for the greater part of two years, and are now regularly treating over 150 tons per day. The low fuel consumption is one of the features of the roasting process, seldom taking more than 2.5 per cent coal in the form of dust of the very cheapest grade, costing 25 cents per ton at the coal mines. It has been found that roasting renders the ore open and porous, making fine grinding unnecessary. From the roasters the ore is sluiced with leaching solution to the leaching tanks. There are six tanks, 20 feet in diameter by 12 feet deep. The lixiviant is an acid-salt solution which dissolves the chlorides of silver and copper, as well as some of the gold and lead. The gold and silver are precipitated on scrap copper, and this precipitate is melted into high-grade silver bullion. The copper and gold are precipitated on scrap iron in separate precipitating boxes.

TOOELE COUNTY.

The production of 147,483 tons reported from Tooele County by 29 operators in 1913 is 121,122 tons less than was reported by 32 producers in 1912. The average value of the ore increased from $7.07 to $10.41 in 1913, and the gold and silver value of this ore was $4 in 1913 against $2.92 in 1912. The total value of the ore sold or treated, containing gold, silver, copper, lead, and zinc was $1,535,994, against $1,900,365 in 1912. The larger part of this value, or $643,274, was for lead, which amounted to 41.88 per cent of the total. The county output consisted of 9,803.87 ounces of gold, valued at $202,664; 640,249 ounces of silver, valued at $386,710; 1,522,596 pounds of copper, valued at $236,002; 14,619,866 pounds of lead, valued at $643,274; and 1,202,568 pounds of zinc, valued at $67,344. The production of gold showed a decrease of $247,968; silver increased 99,388 ounces in quantity and $54,080 in value; the increase in copper yield was 457,098 pounds in quantity and $60,195 in value; the decrease in lead output was 4,405,546 pounds in quantity and $212,870 in value; and the zinc production

[2] Dern, George H., prest., Mines Operating Co., personal communication, June 3, 1914.

decreased 31,524 pounds in quantity and $17,808 in value. Of the total ore produced in the county in 1913, the greater part, or 87,279 tons, was classed as lead ore, of which 61,662 tons were milled and 7,349 tons of oxidized lead ore and 16,197 tons of sulphide lead ore were shipped to the smelters. The quantity of dry or siliceous ores mined decreased from 164,026 tons in 1912 to 56,378 tons in 1913. The copper-lead ores aggregated 1,804 tons, all of which were oxidized and included 20 tons of slag. The copper ores amounted to 104 tons, of which the larger part was oxidized; and 214 tons of lead-zinc ore were produced, of which 176 tons were carbonates. The largest part of the ore mined, or 61,700 tons, was milled, producing 27,414 tons of concentrates. The next largest tonnage was 56,126 tons of siliceous ore, yielding gold bullion, and treated chiefly by the cyanide process in the Camp Floyd district. There were directly shipped to smelters 27,566 tons of ore, which contained $11,207 in gold, 312,540 ounces of silver, 404,160 pounds of copper, 8,389,584 pounds of lead, and 1,186,065 pounds of zinc, having a total value of $698,188, or an average value of $25.33 per ton. Concentrating and jigging plants produced 27,414 tons of concentrates, yielding $5,323 in gold, 321,153 ounces of silver, 1,105,029 pounds of copper, 5,969,148 pounds of lead, 16,503 pounds of zinc, and in total value $634,146, or an average value of $23.13 per ton.

Camp Floyd (Mercur) district.—This district was organized April 16, 1870, and amended by-laws were adopted June 13, 1871. The town of Lewistown was already established as a mining camp in 1869. But little prospecting seems to have been done until 1870 or later. During the 10 years from 1871 to 1881[1] the district probably produced about 46,000 ounces of silver, which is the total mineral production of the camp for that time, since the ores then worked contained no lead, copper, or gold. The gold production of its successor, the Mercur district, became important in 1892.

In June, 1890, the first company to work the gold ores was organized. A 10-ton mill using pan amalgamation was erected and proved a failure; subsequently cyanidation was tried and in 1891 the first gold precipitates were sold to the smelters. From 1890, including 1913, the district produced 920,741.10 ounces of gold bullion, valued at $19,028,560. The silver content of the gold ore was so small that the bullion carried only one ounce of silver to 111 ounces of gold, and it is estimated that 8,295 ounces of silver were recovered from the gold precipitates and bullion to the end of 1913. Dividends were paid by the operating companies between 1893 and 1913 aggregating $3,881,323.

In 1913 three producers reported the mining of 56,126 tons of ore, all of which was treated by the cyanide process and yielded $185,181 in gold and 168 ounces of silver, valued in all at $185, 282, or an average recovery value of $3.30 per ton. The output in 1912 aggregated 163,582 tons of ore, having a total value of $421,027, or an average recovery of $2.57 per ton. The Consolidated Mercur property was closed and its mill was dismantled in 1913, having finished all of its operations with a production of 35,258 tons of ore. The Franklin

[1] Economic geology of the Mercur mining district: U. S. Geol. Survey Sixteenth Ann. Rept., pt. 2, p. 355, 1894–95.

Leasing Co. is reported to have operated at a loss on Geyser-Marion ores. From ore milled on the Daisy property a small quantity of gold was produced.

Clifton district.—Some copper-lead ore was produced in 1913 from one property whose name could not be ascertained.

Columbia district.—The yield of three properties aggregated 439 tons of oxidized and sulphide lead ores, having a total value of $12,590, or an average of $28.67 for the gold, silver, copper, lead, and zinc contents. The principal work was carried on at the New Sultana property in Oak Brush Canyon and at the Mary L or Sharp property.

North Tintic district.—The Scranton mine and lessees of the Bullion group were the principal shippers of zinc, lead, and oxidized lead-zinc ores. The latter was used for the manufacture of pigments at eastern points, and the straight lead ore was purchased by local smelters.

Ophir district.—The output of 10 properties in 1913 aggregated 74,761 tons, consisting chiefly of sulphide lead-silver ores and an important tonnage of oxidized zinc ore. These ores contained $4,898 in gold, 448,673 ounces of silver, 1,462,552 pounds of copper, 9,435,529 pounds of lead, and 769,143 pounds of zinc, valued in all at $960,827. The larger part of the tonnage mined in the district was concentrated and yielded 26,544 tons of lead concentrate, containing also copper, silver, and gold. The 200-ton concentration plant of the Ophir Hill mine was operated the entire year. The Cliff and Hidden Treasure properties contributed the largest part of the tonnage of the ore of shipping grade. There were 10 producers reporting output in 1913, against 11 in 1912.

Rush Valley district.—Seven producers in 1913 mined 14,897 tons of ore, containing $12,094 in gold, 128,675 ounces of silver, 29,521 pounds of copper, 4,619,259 pounds of lead, and 9,019 pounds of zinc, valued in all at $298,142. One-fourth of the output was treated at concentration mills, producing lead concentrates, of which a small tonnage yielded some zinc. The remainder of the production, aggregating 9,287 tons, was of shipping grade and contained 476.90 ounces of gold, 109,730 ounces of silver, 12,914 pounds of copper, and 3,904,888 pounds of lead, valued in all at $249,953, or an average of $26.91 per ton. The crude ore shipped in 1912 aggregated 17,806 tons, with an average value of $27.73 per ton. The Honorine property, under the management of the Bullion Coalition, was successfully operated by the company and lessees. An important tonnage of sulphide lead ore, carrying gold and silver, a little copper, and some zinc, was produced. Other shipments of importance were made from the Galena King, New Stockton, and Muerbrook group.

Silver Islet district.—An increased output of silver-lead ore, containing some copper and gold, was shipped from the Gethin Le-Roy mines in 1913. Considerable active mining has been reported in the district and prospects for the future are reported to be bright.

UINTA COUNTY.

A small production of placer gold was reported from placer operations on Green River. The Fine Gold property installed machinery which is expected by the operators to improve the saving of the fine gold.

UTAH COUNTY.

In 1913 there were mined 18,186 tons of ore by 18 producers. This is 20,016 tons less than was reported by 13 producers in 1912. The total value of the ore in 1913 was $557,913, against $956,058 in 1912. The total average value per ton of the ore increased from $25.03 in 1912 to $30.68 in 1913, and the gold and silver value decreased from $11.15 to $10.51 per ton.

American Fork district.—Through the operations of 8 producers 411 tons of lead ore, chiefly carbonate, were shipped yielding $632 in gold, 6,609 ounces of silver, 2,949 pounds of copper, 279,772 pounds of lead, and 2,712 pounds of zinc, valued in all at $17,542, or an average value of $42.68 per ton. In 1912 the total value amounted to $27,081, or an average of $41.09 per ton. Shipments of crude ore were made from the Blue Rock property, with concentrates containing lead, silver, and a small quantity of copper and gold. The Dutchman, Miller, Live Yankee, and Mineral Flat properties were also producers.

North Tintic district.—A small output of oxidized lead ore was reported shipped from the Lehi-Tintic property.

Santaquin district—Silver-lead sulphide ore was shipped from the Union Chief property the only producer reporting from the district in 1913.

Tintic district.—This district is more fully reviewed under Juab County, where will be found an account of the operations of the more important properties in 1913. The producers on the Utah County side were the Beck Tunnel, Colorado, East Tintic Developopment, May Day, Tintic Standard, Uncle Sam, and Yankee. The production of the Iron Blossom is included in Juab County for the reason that its holdings are largest in that county.

WASHINGTON COUNTY.

The total output of silver in Washington County between 1875 and 1909, when the last reports were received, aggregated 7,195,736 ounces, valued at $7,767,432. The total output of copper between the years 1889 and 1909 aggregated 10,676,002 pounds in quantity and $1,530,849 in value, which, with the value of the silver, gives a total of $9,298,281, as the gross value of the output of Washington County as far as records were available. Some of the operating companies in the Silver Reef district were close corporations, and it is difficult to ascertain what was paid in dividends. The amount has been variously estimated from $900,000 to $1,300,000. There was no production of metal in 1913.

Harrisburg or Silver Reef district.—Silver [1] was discovered in 1869 by John Kemple, who found, near Harrisburg, a piece of float which assayed $17,000. He filled up his small shaft and left the country, but returned with others and organized the Harrisburg district June 22, 1874. He worked his claims for a few months, when, beconimg discouraged, he returned to Star district and was never benefited by the discovery.

The district better known as Silver Reef is in the eastern part of the county, and covers an area about 5 miles square. The old Mor-

[1] Precious Metals: Tenth Census United States, vol. 13, pp. 477–482, 1880.

mon town of Leeds was the settlement nearest the mines in early times and also gave name to the region. As the mines were developed, the town of Silver Reef was built. It is about a mile north of Leeds, 20 miles northeast of St. George, and 90 miles south of the town of Milford, on the San Pedro, Los Angeles & Salt Lake Railroad (formerly the Utah Southern). Daily stages in the eighties connected it with different points, and later, when the railroad was extended, Modena has been the connecting point, 67 miles north of St. George.

The county acquired no importance until August, 1875, when the existence of rich mines [1] became known, and ores containing silver amounting in total to between $10,000 and $15,000 were shipped. Prominence was first given to the district by the discovery of petrified wood, in seams of which silver chloride and native silver occurred.

In 1875 [2] W. H. Barbee, Edward Maynard, and Thomas Y. McNally began to prospect the country. Several claims were located, and the first shipment of 20 tons of ore to Salt Lake City netted $5,700. Some shipments of silver ore were made to Pioche. The Leeds Mining Co. was the first to venture, and in 1876 it started the construction of a 10-stamp mill to crush its own ores, followed by the Dupaix 8-stamp custom mill, both of which were nearly complete at the close of 1876. According to Raymond [3] the most noted claims were the Pride of the West, Susan, Tecumseh, and Buckeye. The claims reported [4] as producing in 1876 were the Buckeye, Butte, Bagley, Bonanza, Barbee, Dixie, Duffin, Shepler, Susan, Tecumseh, Willis, Walker, and others. The district [5] owes its development entirely to W. H. Barbee in 1875. He discovered very rich ore on the Tecumseh mine, and shipped 10 tons of $500 ore to Salt Lake City in November of 1875. He continued the shipment of ore to Salt Lake City and to Pioche during the following year. This caused the rush to the district, principally from Pioche, in the summer and fall of 1876. Up to 1880 the recorder's books showed 640 locations, but probably not over 150 claims were owned at the period under review.

Mills [6] were erected and completed in the Harrisburg district in the following order: Leeds, February, 1877; Pioneer (Dupaix, demolished in fall), 1877; Christy, January 8, 1878; Barbee & Walker, March, 1878 (burned June 23, 1879; rebuilt and placed in operation Feb. 23, 1880); Stormont, July 4, 1878. In 1877 and 1878 many rude leaching works were erected, but, except in cases where the ore was rich and was bought for a trifle, they were unsuccessful. The ore was crushed in arrastres. The proportion saved was from 30 to 60 per cent, averaging about 45 per cent. The Stormont Co. suspended mill operations in February, 1887, and the Christy Co. stopped work in March, 1889. This practically closed the camp. The silver output reached its highest point in 1879, when 995,315 ounces were produced. It continued to decrease each year after until 1889 when the yield was 134,400 ounces and it fell to 60,600 ounces in 1890.

Tutsagubet district.—In 1890 the Tutsagubet district, in which is situated the Dixie copper mine, began important shipments. It is

[1] Raymond, R. W., Mineral resources west of the Rocky Mountains, p. 281, 1876.
[2] Letter to the Salt Lake Tribune from Leeds, Utah, dated Dec. 27, 1876.
[3] Raymond, R. W., op. cit., p. 281.
[4] Salt Lake Tribune, Jan. 1, 1877.
[5] Precious metals: Tenth Census United States, vol. 13, p. 477, 1880.
[6] Idem, pp. 478–479.

reported that years ago the Dixie, then known as the Pen mine, produced 300 tons of copper ore which was shipped to outside smelters; but no record of the output remains, nor is it taken into the estimates of copper production. In 1891 a shipment of 13 tons to Milford, the nearest railway point at that time, cost $30 per ton for freight, but the ore was very rich, containing 54.2 per cent of copper, 4.1 per cent of sulphur, 5.7 per cent of iron, 2.6 per cent of silica, and 4 ounces of silver per ton. Besides copper, some 15 per cent lead ore containing 5 to 25 ounces of silver, was encountered at times in the Dixie mine. In 1891 a copper furnace was erected near St. George and is said to have produced 3 to 4 tons of copper bullion daily. In October, 1899, a new company was incorporated and shortly after a smelter was built at Shem. From this time blister copper was shipped until in 1906, when the plant was closed.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEW MEXICO AND TEXAS IN 1913.

(MINES REPORT.)

By Charles W. Henderson.

NEW MEXICO.[1]

PRODUCTION.

The value of the production of gold, silver, copper, lead, and zinc from New Mexico ores and gravels for 1913, as reported from 128 productive mines, 20 of which were placers, amounted to $11,694,002. As compared with $8,527,955 in 1912, this shows an increase in value for 1913 of $3,166,047. The gold yield was 42,663.17 fine ounces, valued at $881,926, an increase in 1913 of 4,715.60 fine ounces in quantity and of $97,480 in value. The yield of silver was 1,631,273 fine ounces, valued at $985,289, an increase of 94,572 fine ounces in quantity and of $40,218 in value. The copper output was 56,308,706 pounds, an increase in 1913 of 22,277,742 pounds; the lead output was 3,946,364 pounds, a decrease of 1,547,654 pounds; and the zinc output (figured as spelter and zinc in zinc oxide) was 16,523,161 pounds, an increase of 2,956,524 pounds. The value of the base metals showed an increase of $3,112,741 for copper, a decrease of $73,591 for lead and a decrease of $10,801 for zinc (figured at the average yearly price of spelter for each year).

There were 2,217,660 short tons of ore sold or treated in 1913, as compared with 1,352,286 short tons in 1912.

During 1913 there were treated at amalgamating and cyaniding mills in New Mexico 124,536 tons of ore, and the bullion saved amounted to $514,550 in gold, an average value per ton of $4.13, and 1,024,363 ounces of silver, valued at $618,715, an average recovery per ton of 8.23 ounces, and an average value of $4.97, the value in gold and silver being $1,133,265, an average value per ton of $9.10. The recovery as bullion per ton of ore treated in 1912 was $3.959 in gold and $4.876 in silver, a total of $8.835.

From 118,984 tons of ore to amalgamating and cyaniding mills, with concentration equipment, and from 1,987,896 tons to mills for magnetic separation or concentration only—a total of 2,106,880 tons to mills yielding concentrates—there were produced 198,243 tons of concentrates (ratio 11 to 1), valued at $163,584 in gold, an average per ton of $0.825, and 294,948 ounces of silver, valued at $178,149, an average per ton of $0.899, and 51,723,923 pounds of copper, 1,076,848

[1] For discussion of the geology of the districts mentioned in the following pages the reader is referred to the bibliography appended to the report for 1912, in Mineral Resources for 1912, pt. 1, p. 819, 1913, and to Survey Bulletin 507, The mining districts of the western United States, by J. M. Hill, with a geological introduction by Waldemar Lindgren, 1912.

pounds of lead, 8,594,183 pounds of zinc, with a total value for the three base metals of $8,545,863, or $43.11 per ton; a total for the five metals of $44.83 per ton. As the gold and silver come chiefly from a small tonnage of concentrates from the Mogollon district, the copper chiefly from a large tonnage of copper concentrates containing no gold and a little silver from the Central district, and the lead and zinc from concentrates containing little gold and silver from the Magdalena district, these general averages are of little value. Moreover, the tables showing the division of concentrates by kinds must be omitted, to avoid showing individual production.

From the 124,536 tons of ore treated at amalgamating and cyaniding mills, with or without concentration equipment, and from 1,987,896 tons of ore treated at mills for concentration or separation only—a total of 2,112,432 tons milled—there were produced $678,134 in gold and $796,864 in value of silver, from both bullion and concentrates, and $8,545,863 in value of copper, lead, and zinc combined a total value of $10,020,861, at an average of $4.74 per ton for all ore milled.

Crude ore to smelters amounted to 105,228 short tons, containing $195,930 in gold, 311,872 ounces of silver, 4,584,783 pounds of copper, 2,869,516 pounds of lead, and 7,928,978 pounds of zinc. The table showing smelting ore by classes must be omitted to avoid disclosing ndividual production.

Mine production of gold, silver, copper, lead, and zinc in New Mexico from 1904 to 1913 inclusive.

Year.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	102,339	$381,930	214,553	4,972,170	3,122,872	13,493,835	$1,961,390
1905	145,629	317,510	369,192	6,126,025	1,510,209	15,142,254	2,460,535
1906	207,691	293,019	491,127	7,028,670	2,987,369	17,292,655	3,203,739
1907	219,992	329,982	705,544	10,990,015	3,809,881	750,085	3,239,823
1908	135,434	298,757	405,044	6,112,630	873,763	3,576,516	1,525,091
1909	164,156	239,491	397,783	5,393,146	5,029,767	13,085,945	2,070,368
1910	191,865	482,424	843,987	4,614,386	4,320,841	18,088,129	2,691,080
1911	232,699	762,808	1,354,540	4,057,040	2,966,222	10,237,176	2,704,843
1912	1,352,286	784,446	1,536,701	34,030,964	5,494,018	13,566,637	8,527,955
1913	2,217,660	881,926	1,631,273	56,308,706	3,946,364	16,523,161	11,694,002
Increase (+) or decrease (−)	+865,374	+97,480	+94,572	+22,277,742	−1,547,654	+2,956,524	+3,166,047

[a] Includes placer production.

GOLD.

The recoverable gold production from New Mexico ores and gravels in 1913 amounted to 42,663.17 fine ounces, valued at $881,926, as against 37,947.57 fine ounces, valued at $784,446 in 1912, an increase of 4,715.60 fine ounces in quantity and of $97,480 in value. Socorro County alone produced 30,179.03 fine ounces, valued at $623,856, or nearly 71 per cent of the total State yield. This was almost entirely from the siliceous ore mines at Mogollon. There were increased yields of gold in Lincoln, Luna, Otero, Santa Fe, Socorro, and Taos counties. Dry and siliceous ores furnished in the whole State 36,839.28 fine

ounces, valued at $761,535, or 86 per cent of the total. Copper ores contained 4,697.38 fine ounces, valued at $97,103, or 11 per cent of the total, chiefly from Lordsburg, Grant County, and San Pedro, Santa Fe County. Lead ores furnished 707.91 fine ounces, valued at $14,634, or less than 2 per cent of the total, chiefly from Luna County and from Magdalena, Socorro County. Copper-lead and lead-zinc ores furnished less than 1 per cent of the total gold. The production of placer gold amounted to 380.27 fine ounces, valued at $7,861, or almost 1 per cent of the total.

Source of gold production in New Mexico, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placer mines.	Deep mines.					Total.
		Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Copper-lead ores.	Lead-zinc ores.	
Colfax	220.10	754.06					974.17
Dona Ana			0.87	.58			1.45
Grant	79.63	1,699.43	3,242.47	39.32			5,060.85
Lincoln	49.68	2,005.88		.18			2,055.74
Luna				536.24			536.24
Otero	2.02	2,238.05	172.49				2,412.56
Rio Arriba	2.13	.10					2.23
San Miguel		.34					.34
Santa Fe	6.24	198.05	1,095.79				1,300.09
Sierra	20.47	6.51	12.66	1.82			41.46
Socorro		29,837.83	173.10	129.77	12.90	25.43	30,179.03
Taos		99.02					99.02
Total, 1913	380.27	36,839.28	4,697.38	707.91	12.90	25.43	42,663.17
Total, 1912	818.79	29,503.13	7,284.74	309.60	3.43	27.88	37,947.57
Increase (+) or decrease (−)	−438.52	+7,336.15	−2,587.36	+398.31	+9.47	−2.45	+4,715.60

SILVER.

The recoverable silver yield from New Mexico ores in 1913 amounted to 1,631,273 fine ounces, valued at $985,289, as compared with 1,536,701 fine ounces, valued at $945,071, in 1912, an increase for 1913 of 94,572 fine ounces in quantity and of $40,218 in value. Of the total, Socorro County produced 1,347,160 fine ounces, or 83 per cent, chiefly from siliceous ore from the Mogollon district, the remainder from mixed ores of the Magdalena district. Grant County furnished 206,215 ounces, or 13 per cent of the total, chiefly from the Lordsburg district. The yield of silver from Grant and Socorro counties combined was 95 per cent of the total.

Dry and siliceous gold and silver ore, chiefly from Grant and Socorro counties, furnished 1,348,514 fine ounces of silver, or 83 per cent of the total; copper ores, chiefly from Grant and Santa Fe counties, furnished 197,574 ounces, or 12 per cent; lead ores, chiefly from Luna and Socorro counties, furnished 68,923 ounces, or 4 per cent; copper-lead ores, from Socorro County, furnished 4,652 ounces; and lead-zinc ores, from Socorro County, furnished 11,520 ounces, or less than 1 per cent of the total.

Source of silver production in New Mexico, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placer mines.	Deep mines.						Total.
		Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	
Colfax	63	191						254
Dona Ana			154	1,078				1,232
Grant	22	36,906	164,969	4,318				206,215
Lincoln	4	201		895				1,100
Luna			11	41,653				41,664
Otero		5,685	1,403					7,088
Rio Arriba		390						390
San Miguel		73						73
Santa Fe		63	22,013					22,076
Sierra	1	2,004	179	345				2,529
Socorro		1,301,509	8,845	20,634		4,652	11,520	1,347,160
Taos		1,492						1,492
Total, 1913	90	1,348,514	197,574	68,923		4,652	11,520	1,631,273
Total, 1912	140	1,141,786	290,568	68 936	1,167	3,874	30,230	1,536,701
Increase (+) or decrease (−)	−50	+206,728	−92,994	−13	−1,167	+778	−18,710	+94,572

COPPER.

In 1913 the production of copper in New Mexico amounted to 56,308,706 pounds, valued at $8,727,850, an increase of 22,277,742 pounds, as compared with the output of 1912. Grant County, chiefly from the output of the Chino Copper Co., at Santa Rita, and from Hanover, Lordsburg, and Pinos Altos, produced 53,436,177 pounds, or 95 per cent of the total. The increase for the year in Grant County was 21,484,044 pounds. The yield from Otero County increased 614,326 pounds, from Santa Fe County, 988,206 pounds, and from Socorro County, 199,790 pounds.

Copper ores of Dona Ana, Grant, Luna, Otero, Santa Fe, Sierra, and Socorro counties furnished 55,334,759 pounds, or 98.3 per cent of the total; dry and siliceous gold and silver ore (chiefly from the dry ore of Otero County) and from the siliceous ore of Lordsburg district, Grant County, and dry ores of the Magdalena district, Socorro County, furnished 925,593 pounds, or 1.6 per cent; lead ores, chiefly from the Magdalena district, Socorro County, from the Gallinas Mountain district, Lincoln County, and from Central district, Grant County, yielded 26,680 pounds; the lead-zinc mines of Magdalena district furnished 13,776 pounds; and copper-lead ores from Magdalena district, 7,898 pounds.

There were 4,584,783 pounds of copper contained in crude ore shipped to smelters, representing 8 per cent of the total, and concentrates contained 51,723,923 pounds, or 92 per cent.

Source of copper production in New Mexico, by kinds of ore, in 1913, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Colfax	1,147						1,147
Dona Ana		10,184	5				10,189
Grant	138,775	53,292,164	5,238				53,436,177
Lincoln			7,068				7,068
Luna		1,395	58				1,453
Otero	674,943	85,971					760,914
Rio Arriba	385						385
San Miguel	470						470
Santa Fe	170	1,798,599					1,798,769
Sierra	1,960	584	24				2,568
Socorro	107,743	145,862	14,287		7,898	13,776	289,566
Total, 1913	925,593	55,334,759	26,680		7,898	13,776	56,308,706
Total, 1912	395,552	33,528,958	8,724	12,746	40,308	44,676	34,030,964
Increase (+) or decrease (−)	+530,042	+21,805,801	+17,956	−12,746	−32,410	−30,900	+22,277,742

LEAD.

Lead production decreased from 5,494,618 pounds in 1912 to 3,946,364 pounds in 1913. The output in 1913 was valued at $173,640.

The chief lead-producing districts were the Magdelena district, Socorro County; the Victorio district, Luna County; and the Central district, Grant County. Socorro County yielded 2,199,247 pounds, Luna County, 1,158,682 pounds, and Grant County, 446,805 pounds. Concentrates contained 1,076,848 pounds, and crude ore to smelters contained 2,869,516 pounds.

Lead ores furnished 2,623,902 pounds, and lead-zinc ores 1,186,708 pounds, the combined content representing almost 97 per cent of the total.

Sources of lead production in New Mexico, by kinds of ore, in 1913, by counties, in pounds.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Colfax	134						134
Dona Ana			9,557				9,557
Grant	68,010	25,430	353,365				446,805
Lincoln			94,010				94,010
Luna			1,114,914			43,768	1,158,682
Otero	1,911						1,911
San Miguel	2,539						2,539
Santa Fe		794					794
Sierra	383		32,302				32,685
Socorro	14,919		1,019,754		21,634	1,142,940	2,199,247
Total, 1913	87,896	26,224	2,623,902		21,634	1,186,708	3,946,364
Total, 1912	14,860	178,937	3,107,561	33,802	176,220	1,982,638	5,494,018
Increase (+) or decrease (−)	+73,036	−152,713	−483,659	−33,802	−154,586	−795,930	−1,547,654

ZINC.

The total recoverable zinc, whether marketed as spelter or oxide, from crude ore and concentrates (or separation products) shipped from New Mexico in 1913 and figured in terms of spelter and zinc in zinc oxide, was 16,523,161 pounds, valued (in terms of average spelter value for the year) at $925,297. In 1912 the output was 13,566,637 pounds, valued at $936,098. In terms of marketable metal, the value of the zinc contained in ore from New Mexico in 1913 was $59,992 less than the silver output, and $43,371 more than the gold yield.

Mines producing zinc in New Mexico in 1913 were at Kelly, Socorro County; in Cooks, Tres Hermanas, and Victorio districts, Luna County; and in Animas Mountains, Central, and Pinos Altos districts, Grant County.

The ore from the Animas Mountains, Central district, Grant County, and from Luna County, is shipped crude; that from the Pinos Altos district, Grant County, and from Socorro County, is part shipped crude and part separated magnetically and by wet milling.

Zinc ore and concentrates as marketed, in New Mexico, in 1913, by classes of ore, in short tons, and average assay of zinc.

Character.	Quantity.	Average assay.
Carbonate	13,337	34.06
Sulphide (ore and concentrates)	12,389	41.84
Total	25,726	37.81

Source of zinc production in New Mexico, by kinds of ores, in 1913, by counties, in pounds.

County.	Zinc ores.	Lead-zinc ores.	Total.
Grant	2,553,322	.....	2,553,322
Luna	613,218	88,810	702,028
Socorro	10,550,982	2,716,829	13,267,811
Total, 1913	13,717,522	2,805,639	16,523,161
Total, 1912	8,023,361	5,543,276	13,566,637
Increase (+) or decrease (−)	+5,694,161	−2,737,637	+2,956,524

SMELTERS.

The bulk of the smelting lead and copper ores and concentrates continued to be shipped to the El Paso (Tex.) smelter. Some ore and concentrates were shipped to Pueblo and Salida, Colo. Shipments were also made to the Copper Queen smelter at Douglas, Ariz., to the Calumet and Arizona smelter at Douglas, Ariz., to the Shannon smelter at Clifton, Ariz., to the Hayden smelter at Hayden, Ariz., to the Needles smelter at Needles, Cal., and to the Cananea Consolidated Copper smelter, Mexico. Bullion and matte were shipped to the Omaha (Nebr.) refinery, and bullion to Selby, Cal. Zinc ore and concentrates were shipped to smelters and zinc oxide plants in Kansas, Oklahoma, Wisconsin, Illinois, and at eastern points.

Within the State, the San Pedro copper matting plant was operated for 10½ months.

The El Paso Smelting Works, El Paso, Tex., has the following equipment early in 1914. The present plant consists of 6 furnaces for lead ores, with a capacity of 200 tons each, and 3 furnaces for copper ores, with a capacity of 300 tons each per 24 hours. The matte and slag from the copper furnaces flow into 14-foot settlers, the slag being taken by a tram to dumps. Improvements are being made in the slag department. There are five 22-foot diameter Wedge roasting furnaces in the copper department, each with a daily capacity of 200 tons. Three more Wedge furnaces, with 2 more hearths, making 5 each, are being installed. In the reverberatory plant are 2 oil-fired furnaces, each 19 by 95 feet, with a capacity of 350 tons each per day. There are also 2 Pierce-Smith converters, 1 vertical converter, all basic lined, 1 new reverberatory now under construction 24 by 116 feet, expected capacity 525 tons daily.[1]

MINING INDUSTRY IN NEW MEXICO IN 1913.

Not only were large gains made in the mine production of gold, silver, copper, and zinc in New Mexico in 1913 (there being a decrease for lead), but also there was considerable development in various districts, which promises an increased production for 1914. The mine production of gold showed an increase of $97,480 over the output of $784,446 in 1912; that of silver, an increase of 94,572 ounces over the production of 1,536,701 ounces in 1912; lead, a decrease of 1,547,654 pounds from the yield of 5,494,018 pounds in 1912; copper, an increase of 22,277,742 pounds over the yield of 34,030,964 pounds in 1912; and zinc (figured as spelter or zinc in zinc oxide), an increase of 2,956,524 pounds over the output of 13,566,637 pounds in 1912. Despite lower average prices for silver, copper, lead, and zinc, the total value of the output was $11,694,002, an increase for 1913 of $3,166,047.

The Mogollon district, Socorro County, 80 miles from the nearest railroad at Silver City (in Grant County) is the most important district in New Mexico in the output of gold and silver. The production in 1913 of $619,886 in gold and of 1,306,766 ounces of silver was an increase of $95,028 for gold and of 213,608 ounces in quantity and of $116,995 in value for silver. The gold output of this district in 1913 represented 70 per cent of the State yield of this metal, and the silver yield 80 per cent of the total silver output. Nearly all the ore produced is milled in the district by concentration, sliming, and agitation and percolation in cyanide solution, the bulk of the product being cyanide precipitates, with several cars of high-grade gold-silver concentrates. The milling ore is siliceous, oxidized, and sulphide, with very little base metals carrying (in 1913, in terms of recovered metal) an average per ton of 0.2591 ounce, or $5.356 in gold, and 11.29 ounces, or $6.82, in silver. In 1913 several cars of high-grade copper ore, carrying very appreciable quantities of gold and silver, were shipped. In one or two veins are found important quantities of the copper minerals, bornite and chalcocite. The auriferous pyritic quartz veins of White Oaks, Lincoln County,

[1] See also Min. and Sci. Press, Feb. 21, 1914, p. 350.

have yielded a large quantity of gold, and in 1913 there was a heavy increase in the output of amalgamation bullion and cyanide precipitates. The Elizabethtown district, Colfax County, in point of total production to date, one of the leading mining districts in New Mexico, both from placers and lode mines, remained the most important placer district in the State, despite a heavy decrease in placer yield. The Aztec mine and amalgamation-concentration-cyanidation mill were operated, and development and sampling of the Ajax mine continued. The Lordsburg district, Grant County, with a small yield of gold and silver compared with the Mogollon district, ranked second in the output of precious metals, despite a heavy decrease in the shipments of siliceous gold-and-silver-bearing copper and dry ores from fissure veins. (The low-grade copper deposits of the Chino Copper Co., at Santa Rita, carry practically no precious metals.) In 1913 heavily increased shipments of sulphide ores of gold and copper from the Jarilla district, near Orogrande, Otero County, placed this district almost in the same rank with the Lordsburg district as a producer of gold, but there is comparatively little silver in the Jarilla district ores, while the Lordsburg district's yield of silver is greater in value than its yield of gold. Shipments of various classes of ore from Pinos Altos placed that district after Lordsburg, White Oaks, and Jarilla districts in the yield of gold and after Lordsburg, Magdalena, and Victorio districts in the yield of silver. The continued operations throughout 1913 of the mines and matte smelter of the Santa Fe Gold & Copper Co., at San Pedro, Santa Fe County (reopened in July, 1912, after being idle since 1907), placed this district after Pinos Altos district in the yield of both gold and silver. The yield of the sulphide ores, carrying gold, silver, copper, and lead, of the Las Animas district, near Hillsboro, Sierra County, as well as the yield of placer gold, decreased considerably. The Cochite (Bland) district, Rio Arriba County, inactive since 1904, but with a record from 1894 to 1904 of $695,000 in gold and $345,000 in silver, was reopened in December, 1913, and the erection of an 100-ton custom cyanidation plant was begun. In the Red River district, Taos County, in which gold is the predominant metal, but also with silver, copper, and lead, made a small yield of gold and silver as the output of a small cyanidation mill. During 1913 another small cyanidation mill was erected.

Copper has been an important metal in the production of New Mexico, the recorded output from 1845 to 1910 having been 92,323,163 pounds.[1] The output of copper for 1911, 1912, and 1913, respectively, has been 4,057,040 pounds, 34,030,964 pounds, and 56,308,706 pounds; a total from 1845 to 1913, inclusive, of 186,719,873 pounds. Since 1910 the increased production is due principally to the output of the Chino Copper Co., mining with steam shovels a large acreage of low-grade copper deposits at Santa Rita and milling at Hurley, in a wet-concentration plant of five sections, where an average of 5,322 tons per day was treated during 1913, and where it has been demonstrated that considerably in excess of 6,000 tons per day can be treated. The company reports ore reserves of over 90,000,000 tons of 1.8 per cent copper, and predicts an increase of 30 per cent in the output of copper per annum over the production of 53,170,145 pounds (gross output)

[1] Butler, B. S., U. S. Geol. Survey, Mineral Resources, 1910, pt. 1, p. 204, 1911.

in 1913. The copper output from Lordsburg, Grant County, decreased 49 per cent, as compared with the record yield of 1912. The mines and 125-ton matting plant at San Pedro, Santa Fe County, were operated for 10½ months in 1913, as compared with six months in 1912. The production of copper from the Jarilla district, Otero County increased over 300 per cent. In the Burro Mountain district, Grant County, the Burro Mountain Copper Co. built a railroad from White Water to Tyrone, advanced its haulage tunnel 3,753 feet, and selected a site for a concentrating plant of 1,000 tons daily capacity.

The yield of lead decreased appreciably. The yield from the lead and lead-zinc ores of Magdalena showed little change, and the output from the lead ores of Luna County increased considerably, but the yield from the Central district, Grant County, fell off heavily. The Organ district, Dona Ana County, an important producer of lead from 1854 to 1909, had only a small yield in 1913.

From the State, in 1913, zinc sulphide ore and concentrates shipped amounted to 12,389 dry tons of 41.84 per cent zinc, and zinc carbonate ore to 13,337 tons of 34.06 per cent; a total of 25,776 dry tons averaging 37.81 per cent zinc. The principal zinc-producing district in 1913 was at Kelly, Socorro County, where are located the mines and magnetic separation and wet-concentration mill of the Tri-Bullion Co. (now owned by the Empire Zinc Co.), and the mines and new (in 1913) wet-concentration mill of the Ozark Co. Crude zinc carbonate, and zinc sulphide ores, and zinc sulphide concentrates were shipped from Kelly. In Grant County, zinc carbonate ore was shipped from Hanover, and zinc ore and concentrates were shipped from Pinos Altos. Zinc carbonate ore was mined in 1913 in the Animas Mountains district, Grant County, and shipped in 1914. Zinc carbonate ores were shipped from the Cooks and the Tres Hermanas districts, Luna County.

The following tables show the results of mining operations in New Mexico in 1913:

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1913, by counties.

County.	Number of mines producing.	Tonnage.	Gold.[a]		Silver.[a]	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
Colfax	8	3,222	974.17	$20,138	254	$153
Dona Ana	3	155	1.45	30	1,232	744
Grant	53	1,984,304	5,060.85	104,617	206,215	124,554
Lincoln	5	5,589	2,055.74	42,496	1,100	664
Luna	9	5,185	536.24	11,085	41,664	25,165
Otero	12	25,582	2,412.56	49,872	7,088	4,281
Rio Arriba	2	10	2.23	46	390	236
San Miguel	1	29	.34	7	73	44
Santa Fe	6	29,800	1,300.08	26,875	22,076	13,334
Sierra	10	269	41.46	857	2,529	1,528
Socorro	17	163,405	30,179.03	623,856	1,347,160	813,685
Taos	2	110	99.02	2,047	1,492	901
Total, 1913	128	2,217,660	42,663.17	881,926	1,631,273	985,289
Total, 1912	145	1,352,286	37,947.57	784,446	1,536,701	945,071
Increase (+) or decrease (−)	−17	+865,374	+4,715.60	+97,480	+94,572	+40,218

[a] Includes placer production.

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1913, by counties—Continued.

County.	Copper.		Lead.		Zinc.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Colfax	1,147	$178	134	$6	.....	.....	$20,475
Dona Ana	10,189	1,579	9,557	421	.....	.....	2,774
Grant	53,436,177	8,282,607	446,805	19,659	2,553,322	$142,986	8,674,423
Lincoln	7,068	1,096	94,010	4,136	.....	.....	48,392
Luna	1,453	225	1,158,682	50,982	702,028	39,314	126,771
Otero	760,914	117,942	1,911	84	.....	.....	172,179
Rio Arriba	385	60	.....	.....	.....	.....	342
San Miguel	470	73	2,539	112	.....	.....	236
Santa Fe	1,798,769	278,809	794	35	.....	.....	319,053
Sierra	2,568	398	32,685	1,438	.....	.....	4,221
Socorro	289,566	44,883	2,199,247	96,767	13,267,811	742,997	2,322,188
Taos	.....	.....	.....	.....	.....	.....	2,948
Total, 1913	56,308,703	8,727,850	3,946,364	173,640	16,523,161	925,297	11,694,002
Total, 1912	34,030,964	5,615,109	5,494,018	247,231	13,566,637	936,098	8,527,955
Increase (+) or decrease (−)	+22,277,742	+3,112,741	−1,547,654	−73,591	+2,956,524	−10,801	+3,166,047

Tonnage of ore to gold and silver mills and concentrating mills, with quantity of gold and silver in bullion produced in New Mexico from 1909 to 1913, inclusive.

Year.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
1909	32,830	6,725.84	169,650	78,782
1910	67,148	14,220.94	412,272	61,379
1911	109,113	21,894.14	771,014	59,622
1912	106,208	20,342.58	842,018	1,142,002
1913	124,536	24,891.37	1,024,363	1,987,896
Increase (+) or decrease (−)	+18,328	+4,548.79	+182,345	+854,894

Mine production of gold, silver, copper, lead, and zinc from New Mexico concentrates from 1909 to 1913, inclusive.

Year.	Concentrates produced.					
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	7,554	1,598.31	112,639	2,015,118	436,558	821,766
1910	18,298	4,536.03	255,060	1,050,238	2,701,843	6,882,175
1911	16,243	7,938.70	333,654	1,125,927	1,562,768	5,304,000
1912	81,811	7,190.63	290,081	28,760,908	1,984,435	6,404,768
1913	198,243	7,913.39	294,948	51,723,923	1,076,848	8,594,183
Increase (+) or decrease (−)	+116,432	+722.76	+4,867	+22,963,015	−907,587	+2,189,415

Mine production of gold, silver, copper, lead, and zinc from New Mexico crude ore shipped to smelters from 1909 to 1913, inclusive.

Year.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	52,544	2,196.50	115,332	3,378,028	4,593,209	12,264,179
1910	63,338	3,317.99	176,281	3,564,148	1,618,998	11,205,954
1911	63,961	6,162.71	249,710	2,931,113	1,403,454	4,933,176
1912	104,076	9,595.57	404,462	5,270,056	3,509,583	7,161,869
1913	105,228	9,478.13	311,872	4,584,783	2,869,516	7,928,978
Increase (+) or decrease (−)	+1,152	−117.44	−92,590	−685,273	−640,067	+767,109

Mine production of gold, silver, copper, lead, and zinc from New Mexico crude ore and concentrates combined shipped to smelters from 1909 to 1913, inclusive.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1909	60,068	3,794.81	227,971	5,303,146	5,029,767	13,085,945
1910	81,636	7,854.62	431,341	4,614,386	4,320,841	18,088,129
1911	80,267	11,161.41	583,364	4,057,040	2,966,222	10,237,176
1912	185,837	15,765.20	694,543	31,030,964	5,494,018	13,566,637
1913	303,471	17,391.52	606,820	56,308,706	3,946,364	16,523,161
Increase (+) or decrease (−)	+117,584	+605.32	−87,723	+21,277,742	−1,547,654	+2,956,524

Tonnage of ore to gold and silver mills and concentrating mills, with quantity of gold and silver in bullion produced in New Mexico in 1913, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Colfax	3,150	470.74	93	.....
Grant	.....	.....	.....	1,943,996
Lincoln	5,432	2,005.88	261	.....
Otero	.....	.....	.....	9,520
Santa Fe	166	87.04	21	.....
Sierra	.....	.....	.....	180
Socorro	115,678	22,228.69	1,022,556	34,200
Taos	110	99.02	1,492	.....
Total	124,536	24,891.37	1,024,363	1,987,896

Mine production of gold, silver, copper, lead, and zinc from New Mexico concentrates in 1913, by counties.

County.	Concentrates produced.					
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Colfax	5	27.93	12	73	.....	.....
Grant	183,548	223.00	6,443	51,575,040	.....	241,071
Otero	272	.....	336	132,810	.....	.....
Santa Fe	22	45.76	19	170	.....	.....
Sierra	9	3.53	936	1,930	.....	.....
Socorro	14,387	7,613.17	287,202	13,900	1,076,848	8,353,112
Total	198,243	7,913.39	294,948	51,723,923	1,076,848	8,594,183

Mine production of gold, silver, copper, lead, and zinc from New Mexico crude ore shipped to smelters in 1913, by counties.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Colfax	72	255.40	86	1,074	134	.....
Dona Ana	155	1.45	1,232	10,189	9,57	.....
Grant	40,308	4,758.22	199,750	1,861,137	446,805	2,312,251
Lincoln	157	.18	895	7,068	94,010	.....
Luna	5,185	536.24	41,664	1,453	1,158,682	702,028
Otero	16,062	2,410.54	6,752	628,104	1,911	.....
Rio Arriba	10	.10	390	385	.....	.....
San Miguel	29	.34	73	470	2,539	.....
Santa Fe	29,634	1,161.04	22,036	1,798,599	794	.....
Sierra	89	17.46	1,592	638	32,685	.....
Socorro	13,527	337.17	37,402	275,666	1,122,399	4,914,699
Total	105,228	9,478.14	311,872	4,584,783	2,869,516	7,928,978

Tonnage of ore to gold and silver mills, with quantity of gold and silver contained in bullion produced in New Mexico in 1913, by processes.

Quantity.	Process.	Gold in bullion.	Silver in bullion.
Short tons.		*Fine ounces.*	*Fine ounces.*
7,638	Amalgamation	2,424.63	300
116,898	Cyanidation	22,466.74	1,024,063
124,536	.....	24,891.37	1,024,363

Consumption of quicksilver and cyanide in New Mexico mills in 1913.

Quicksilver.	Potassium cyanide.	Sodium cyanide.
Pounds.	*Pounds.*	*Pounds.*
[a] 133	[b] 1,415	[b] 190,190

[a] Represents 1 pound of quicksilver for every 18.23 ounces of gold.
[b] Represents 1 pound of cyanide for every 0.117 ounces of gold, and 1 pound of cyanide for every 5.34 ounces of silver.

Subdivision of tonnage of ore sold or treated in New Mexico in 1913, by counties, in short tons.

County.	Dry and siliceous gold and silver ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Colfax	3,222	.....	.....	.....	.....	.....	3,222
Dona Ana	.....	115	40	.....	.....	.....	155
Grant	3,837	1,974,245	981	5,241	.....	.....	1,984,304
Lincoln	5,432	.....	157	.....	.....	.....	5,589
Luna	.....	4	4,129	930	.....	122	5,185
Otero	24,397	1,185	.....	.....	.....	.....	25,582
Rio Arriba	10	.....	.....	.....	.....	.....	10
San Miguel	29	.....	.....	.....	.....	.....	29
Santa Fe	199	29,601	.....	.....	.....	.....	29,800
Sierra	186	5	78	.....	.....	.....	269
Socorro	117,185	859	2,377	34,268	103	8,613	163,405
Taos	110	.....	.....	.....	.....	.....	110
Total, 1913	154,607	2,006,014	7,762	40,439	103	8,735	2,217,660
Total, 1912	117,167	1,195,683	6,852	16,394	398	15,792	1,352,286
Increase (+) or decrease (−)	+37,440	+810,331	+910	+24,045	−295	−7,057	+865,374

Output of ore and placers, and production of metals in New Mexico, by kinds of ore, in 1913.

Source of production.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers		380.28	90			
Dry and siliceous gold and silver ores	154,607	36,839.27	1,348,514	925,593	87,896	
Copper ores	2,006,014	4,697.38	197,574	55,334,759	26,224	
Lead ores	7,762	707.91	68,923	26,680	2,623,902	
Zinc ores	40,439					13,717,522
Copper-lead ores	103	12.90	4.652	7,898	21,634	
Lead-zinc ores	8,735	25.43	11,520	13,776	1,186,708	2,805,639
Total	2,217,660	42,663.17	1,631,273	56,308,706	3,946,364	16,523,161

REDUCTION MILLS IN NEW MEXICO IN 1913.

Mineral Resources for 1912, part 1, pages 832–835, contained a complete list of the reduction mills in New Mexico in 1912, with description of equipment and process. Any changes in this list for 1913 have been noted in the text of the various counties, and reference should be made to the 1912 report for detailed equipment. The Tri-Bullion mill, in the Magdalena district, has a capacity of only 60 tons per day or 1,800 tons per month.

REVIEW BY COUNTIES.[1]

BERNALILLO COUNTY.[2]

No ore was marketed from Bernalillo County in 1913. There are several prospects in the Coyote, Hell Canyon, and Soda Springs districts, in this county.

COLFAX COUNTY.[3]

Elizabethtown district (including Baldy).— Despite a yield of only $4,550 in placer gold in 1913, as compared with $8,385 in 1912, this district remained the principal producing placer district in New Mexico.

Producing lode mines were the Aztec and Golden Ajax. Oxidized ore from the Aztec mine was milled in the 40-stamp plate-amalgamation and concentration mill on the property. Only 10 stamps were in use. Sulphide ore was shipped to Colorado smelters. Oxidation extends from 50 to 250 feet. A small tonnage of old tailings was treated at the Golden Ajax 25-ton cyanide plant, consisting of stamps, tube mill, and Paterson hydraulic agitator. Considerable development work, sampling, and assaying were done at the Golden Ajax mine.

The following table shows the production of Elizabethtown and Baldy districts (which is the output for Colfax County) from 1904 to 1913, inclusive.

[1] Discussions of the geology of the several districts are given in the publications cited in many of the footnotes in this section.

[2] Lindgren, Waldemar, The ore deposits of New Mexico: U. S. Geol. Survey Prof. Paper 68, pp. 162–163, 1910.

[3] Idem, pp. 18, 32, 36, 41, 51–54, 57–59, 60, 75, 91–108, 348.

Mine production in Elizabethtown district, Colfax County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	380	$90,639	$3,638	67	.....	.....	$94,316
1905	13	31,994	445	157	.....	.....	31,749
1906	.....	14,492	.....	93	.....	.....	14,554
1907	.....	11,914	.....	83	.....	.....	11,969
1908	.....	11,274	.....	66	.....	.....	11,309
1909	83	16,037	1,705	127	.....	.....	17,808
1910	93	9,588	3,433	261	.....	2,182	13,258
1911	2,306	9,860	31,547	1,254	5,587	.....	42,770
1912	3,025	8,385	27,316	634	6,243	.....	37,121
1913	3,222	4,550	15,588	254	1,147	134	20,475
Increase (+) or decrease (−)	+197	−3,835	−11,728	−380	−5,096	+134	−16,646

DONA ANA COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Dona Ana County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fineounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	5,580	.....	24,101	40,000	1,581,488	.....	$87,145
1905	6,566	$6,710	21,776	96,058	327,707	30,000	52,020
1906	16,220	.....	34,051	434,000	1,207,193	.....	175,386
1907	6,084	6	25,612	776,125	675,189	.....	207,920
1908	3,090	.....	9,283	21,150	379,697	.....	23,660
1909	2,816	248	16,975	10,600	772,023	.....	43,650
1910	2	.....	15	.....	705	.....	39
1911	5	.....	111	353	1,561	.....	173
1912	78	17	1,790	6,685	26,129	.....	3,397
1913	155	30	1,232	10,189	9,557	.....	2,774
Increase (+) or decrease (−)	+77	+13	−558	+3,504	−16,572	.....	−623

Organ Mountains district.[1]—Several cars of lead and copper ores were shipped from this district. The Homestake mine is opened by an incline shaft 216 feet deep, with oxidized ores to 150 feet. A body of iron sulphide ore, carrying 35 per cent iron and a good commercial grade of silver, was opened during the year. Some development work was done on other properties in the district.

[1]Lindgren, Waldemar, op. cit., pp. 205–213.

GRANT COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Grant County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	47,032	$8,081	$60,347	74,793	4,428,508	179,142	.....	$695,009
1905	81,160	10,943	35,064	86,629	5,291,222	321,035	257,203	954,026
1906	127,800	2,290	97,519	163,987	6,388,830	710,895	144,656	1,492,069
1907	146,746	3,782	109,260	224,279	8,046,315	1,394,390	73,729	1,948,582
1908	75,254	3,514	42,168	95,477	5,242,767	244,589	251,070	810,403
1909	89,576	3,584	34,242	74,198	5,176,585	215,070	203,278	769,590
1910	70,862	2,641	63,291	156,557	4,404,394	257,953	1,285,500	790,598
1911	93,770	4,043	112,241	221,882	3,918,928	694,247	306,895	772,481
1912	1,200,691	2,551	163,645	356,057	32,952,133	2,309,732	3,135,000	6,142,526
1913	1,984,304	1,646	102,971	206,215	53,436,177	446,805	2,553,322	8,674,423
Increase(+) or decrease(−)	+783,613	−905	−60,674	−149,842	+20,484,044	−1,862,927	−581,678	+2,531,897

Apache No. 2 (Anderson) district.[1]—A small tonnage of low-grade oxidized copper ore, carrying some silver, was shipped from the Apache mine, 6 miles from Hachita.

Burro Mountain district.[2]—Several cars of copper ore were shipped by lessees from the dump of the Savanna Copper Co.'s property. A small shipment of copper ore was made by the Ocala Copper Co. Development work was done on the properties of the Burro Mountain Co., which completed a branch railroad from Whitewater to Tyrone. Phelps, Dodge & Co., in its 1913 report, states—

> that the Burro Mountain Copper Co., Tyrone, N. Mex., has advanced its Niagara haulage tunnel 3,753 feet, making the total length 4,286 feet. This tunnel is to deliver ore from the Burro Mountain claims at the railroad terminus and to explore the intermediate ground. Toward the end of the year a prospect drift was turned from the main tunnel at a point about 1,200 feet from the portal and revealed a body of low-grade sulphide ore. Development of this ore has so far opened up 50,000 tons of ore averaging 2.35 per cent copper. A site for a concentrating plant of 1,000 tons daily capacity has been selected about 3 miles from Tyrone.[3]

A testing plant will be built to obtain data from which to design a combination flotation, concentration, and leaching works.[4]

Some churn drilling was done on the property of the Mangus Co.

Central district.[5]—The output of the Central district, embracing the towns of Bayard, Fierro,[6] Georgetown,[7] Hanover,[8] and Santa Rita,[8] was 1,948,471 tons, yielding $9,697 in gold, 12,500 ounces of

[1] As distinguished from Apache (Chloride) district, Sierra County. See Hill, J. M., Mining districts of western United States: U. S. Geol. Survey Bull. 507, pp. 231, 240, 1912.
Lindgren, Waldemar, op. cit., pp. 343-344.
Weed, W. H., The copper mines of the United States in 1905; U. S. Geol. Survey Bull. 285, p. 118, 1906.
[2] Lindgren, Waldemar, op. cit., pp. 17, 19, 27, 28, 38, 61, 62, 321-324.
Paige, S., Metalliferous ore deposits near the Burro Mountains, Grant County: U. S. Geol. Survey Bull. 470, pp. 131-150, 1911.
Weed, W. H., op. cit., p. 118.
[3] Eng. and Min. Jour., May 9, 1914, p. 955.
[4] Idem, p. 953.
[5] Lingdren, Waldemar, op. cit., pp. 57, 61, 317-318; Weed, W. H., op. cit., p. 118.
[6] Lindgren, Wildemar, op. cit., pp. 47, 55, 296, 306, 312-313.
Paige, Sidney, The Hanover iron-ore deposits, New Mexico: U. S. Geol. Survey Bull. 380, pp. 199-214, 1909.
[7] Lindgren, Waldemar, op. cit., pp. 18, 30, 38, 62, 63-65, 306-307, 318-319.
[8] Birkinbine, John, Iron ores of the United States: U. S. Geol. Survey Eighteenth Annual Rept., pt. 5, pp. 48-50, 1897.
Lindgren, Waldemar, op. cit., pp. 3, 5, 18, 38, 41-43, 51-53, 55, 57-58, 305, 317.
Paige, Sidney, op. cit., pp. 119-214.
Weed, W. H., op. cit., p. 118.

silver, 51,695,656 pounds of copper, 331,440 pounds of lead, and 2,187,266 pounds of zinc, with a total value of $8,167,144, as compared with $5,138,779 in 1912. This district is the first in New Mexico in point of present production, the value of the output representing nearly 70 per cent of the State yield. Besides the Chino Copper Co.'s mines at Santa Rita, there were 17 other producing mines in this district. From Hanover, zinc carbonate ore was shipped from the Mountain Home group, Welch group, and Empire Zinc Co.'s mines. Oxidized copper ore was shipped from the Copper Queen property, at Fierro; the shaft was sunk 200 feet. Lead ore was shipped from the Lucky Bill mine and from the Silver King, near Bayard. A considerable tonnage of ore was shipped from various dumps in the district.

The Chino Copper Co. is mining a low-grade copper deposit at Santa Rita by steam shovel. The ore is concentrated at Hurley, where is located a 6,000-ton plant, in five sections. Concentrates are shipped to El Paso.

The fourth annual report of the Chino Copper Co., dated April 15, 1914, covering the year ended December 31, 1913, says—

* * * no pronounced attempt was made to develop increased tonnages; but sufficient drilling was done to indicate an added development of ore in excess of the amount treated for the year, which results in an available tonnage of over 90,000,000 tons as of January 1, 1914, of an average grade of 1.8 per cent copper.

During the year, the gross production of copper amounted to 53,170,145 pounds, the net production 50,511,611 pounds. The output was produced with the plant operating only four sections out of the five for the first five months of the year. The total tonnage milled for the year, 1,942,700 tons, is equivalent to an average for the year of 5,322 tons per day. The operation of the plant for the last seven months of the year has clearly demonstrated an average capacity considerably in excess of 6,000 tons per day. The average net cost of copper produced during the year, including all operating expenses of every kind, mining, transportation, milling, smelting, and selling, and crediting all miscellaneous income, was 8.49 cents per pound. Sales and deliveries of copper for the year were made at the gross price of 15.489 cents per pound, or, after deducting delivery charges, 15.322 cents. * * * An increase of 30 per cent in the output of copper per annum over the production of the year just ended can be expected with the present perfected and completed plant. * * *

The average copper content of the ore treated for the year was 2.033 per cent. The total production of concentrates was 183,117 dry tons, corresponding to a ratio of 10.61 tons of ore to produce 1 ton of concentrates. The total amount of copper contained in concentrates was 53,170,145 pounds, corresponding to an average content of 14.518 per cent copper and a recovery of 27.37 pounds of copper per ton of ore treated, which represents an extraction of 67.31 per cent of the copper contained in the ore. The low ratio of concentration was due entirely to the high iron contents of the ores of certain sections of the mine. * * * [1]

The following table shows the production of Central district from 1904 to 1913:

[1] For description of previous operations, see Henderson, Charles W., U. S. Geol. Survey Mineral Resources for 1910, pt. 1, p. 546, 1911; idem, 1911, pt. 1, pp. 715–716, 1912; and idem, 1912, pt. 1, p. 837, 1913.

Production of gold, silver, copper, lead, and zinc in the Central district, Grant County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	21,048	$5,582	282	3,264,208	11,977	.....	$430,607
1905	17,115	.....	.....	2,704,233	.....	.....	421,860
1906	39,155	4	2,524	3,075,001	235,070	99,656	614,648
1907	57,079	5,659	36,813	4,994,575	855,358	73,729	1,078,555
1908	41,852	777	296	3,994,502	29,122	251,070	541,231
1909	41,456	816	1,380	3,318,808	23,256	203,278	448,856
1910	37,008	.....	404	2,679,630	155	1,285,500	409,955
1911	45,584	104	8,673	1,413,189	605,978	290,122	325,156
1912	1,136,290	998	29,586	29,512,812	2,172,676	2,205,824	5,138,779
1913	1,948,471	9,697	12,500	51,695,656	331,440	2,187,266	8,167,144
Increase (+) or decrease (−)	+812,181	+8,699	−17,086	+22,182,844	−1,841,236	−18,558	+3,028,365

Chloride Flat district (near Silver City.[1])—Lead-silver ore was shipped from the Grand Central mine.

Eureka district (Hachita, including Sylvanite).[2]—No production was made from this district in 1913.

Fremont district.—Several cars of copper ore were shipped from the Nutshell mine, near the boundary lines of Luna and Grant counties and Mexico.

Gillespie, or Animas Mountains district.—Zinc carbonate ore, containing also some lead, silver, and copper, was mined at the White Rose mine and shipped in January, 1914. Development work was done throughout the year.

Lordsburg district (including Pyramid and Virginia, or Shakespeare districts).[3]—The following table shows the production of Lordsburg district from 1904 to 1913, inclusive:

Production of gold, silver, copper, and lead in the Lordsburg district, Grant County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	250	$1,184	2,580	18,200	12,000	$5,582
1905	366	10	7,584	48,000	.....	12,079
1906	1,743	5,168	27,261	212,601	.....	64,465
1907	5,645	8,761	31,303	463,335	10,522	122,646
1908	7,532	10,617	9,889	259,079	11,363	50,534
1909	10,690	25,983	50,154	589,969	8,862	129,140
1910	29,220	59,798	130,324	1,627,591	19,662	337,742
1911	46,139	106,648	182,448	2,455,336	2,157	510,359
1912	55,340	144,859	275,251	3,155,585	4,562	835,015
1913	31,284	55,234	154,779	1,601,461	14,572	397,588
Increase (+) or decrease (−)	−24,056	−89,625	−120,472	−1,554,124	+10,010	−437,427

The yield from this district decreased heavily in 1913. With the exception of one small lot of lead ore from the Ontario claim, all the ore from this district was siliceous, carrying chiefly copper, but also appreciable quantities of gold and silver. All the ore is shipped

[1] Lindgren, Waldemar, op. cit., pp. 18, 26, 38, 63–65, 301–305, 1910.
[2] Idem, pp. 335–343.
[3] Graton, L. C., idem, pp. 332–335; Weed, W. H., op. cit., p. 118.

to smelters. The average assay per ton for the district in 1913 was gold, 0.085 ounce, silver 4.948 ounces, and copper 2.56 per cent. The principal producing mines were the Bonney, Eighty-five, Miser's Chest, Nevada, Robert E. Lee, and Southern.

Pinos Altos district.[1]—The following table shows the production of Pinos Altos district from 1904 to 1913, inclusive:

Production of gold, silver, copper, lead, and zinc in the Pinos Altos district, Grant County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	4,719	$7,750	$49,660	37,229	104,069	2,653	.....	$92,587
1905	6,348	10,943	31,442	39,585	103,469	.....	160,779	82,442
1906	14,074	2,290	89,674	83,566	328,788	.....	.....	211,409
1907	14,841	3,782	78,723	65,862	322,195	.....	.....	190,413
1908	1,451	1,479	8,548	8,941	34,514	3,953	.....	21,528
1909	38	3,584	2,083	1,377	6,200	418	.....	7,207
1910	20	2,494	1,372	223	269	2,226	.....	4,119
1911	355	4,043	1,406	5,616	3,232	4,063	16,773	9,968
1912	6,169	2,551	7,973	15,864	96,507	50,289	929,176	102,581
1913	3,643	1,646	29,162	28,276	100,555	83,067	366,056	87,626
Increase (+) or decrease (−)	−2,526	−905	+21,189	+12,412	+4,048	+32,778	−563,120	−14,955

Placer mines in this district in 1913 yielded only $1,646 in gold and 22 ounces of silver, and deep mines yielded 3,643 tons of ore, having a gross value of $85,967 for all five metals, the total value for the district being $87,626, as against $102,581 in 1912. The principal producing mines were the Cleveland, yielding chiefly zinc ore to smelter and zinc concentrates, and the Gillette mine of the Savanna Copper, Co., yielding all five metals in shipments to smelters. Other producing mines were the Arizona, Copper Bell, Langston, Lead Hill, Manhattan, and Mountain Key.

Red Hill district.—No ore was shipped from this district, which lies in the southwest corner of New Mexico.

San Simon (Granite Gap[2]*) district (Steins).*—Development work was done on the Granite Gap mine and other properties.

Steeple Rock district[3].—Shipments of various kinds of ore and bullion were made from the Carlysle-Nugget mine. A considerable tonnage of gold-silver sulphide ore was shipped from the New Strike mine.

Steins Pass (Kimball[4]*) district.*—A small tonnage of ore was shipped from the National property.

White Signal (Cow Springs) district (Whitewater).—Several lots of ore were shipped from this district.

[1] Lindgren, Waldemar, op. cit., pp. 18, 35, 38, 43, 57–58, 59, 61, 62, 64, 75, 297–301. Paige, Sidney, The ore deposits near Pinos Altos, N. Mex.: Bull. U. S. Geol. Survey No. 470, 1911, p. 109–125.
[2] Lindgren, Waldemar, op. cit., pp. 51, 53, 62, 63–64, 329–331, 340.
[3] Idem, pp. 68, 69–71, 327–328.
[4] Idem pp. 68, 69–70, 328–329.

LINCOLN COUNTY.

Mine production of gold, silver, copper, and lead in Lincoln County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	820	$20,100	$8,496	2,576	.....	2,261	$30,183
1905	3,060	2,260	5,215	757	14,404	7,511	10,532
1906	6,380	.....	16,463	1,946	.....	.....	17,767
1907	5,767	.....	41,417	721	.....	.....	41,893
1908	4,399	816	28,896	5,472	1,195	.....	32,770
1909	3,633	472	23,391	388	700	7,977	24,499
1910	10,727	1,400	53,876	559	189	5,614	55,849
1911	1,578	1,629	30,305	184	555	6,620	32,399
1912	2,003	1,008	21,408	1,005	9,988	103,911	29,358
1913	5,589	1,027	41,469	1,100	7,068	94,010	48,392
Increase (+) or decrease (−)	+3,586	+19	+20,061	+95	−2,920	−9,901	+19,034

The value of the mine production in 1913 in Lincoln County, from both deep and placer mines, was $48,392, as compared with $29,358 in 1912. The placer yield remained practically the same, but the deep mine output increased from $28,347 to $47,363.

Gallinas district.[1]—Several cars of lead ore, carrying also copper and silver, were shipped.

Jicarilla district.[2]—The placer output of the county comes from this district. The yield of placer gold was $1,027 in 1913, as against $1,008 in 1912.

Nogal (Bonita, Parsons) district.[3]—Assessment work only was done in this district in 1913.

Whiteoaks district.[4]—The output from the Whiteoaks district, chiefly gold, increased materially. The Wild Cat Leasing Co. operated the North and South Homestake mines and amalgamation mill continuously. The cyanide plant of the Homestake mill was operated under another lease on dump ore from the mines. The mill as a whole has a capacity of 80 tons per day, with equipment as follows: 20 stamps, 1 Dorr classifier, 2 Overstrom concentrating tables, 16 cyanide tanks, 1 Oliver filter.

LUNA COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Luna County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	1,576	$1,695	8,549	16,000	671,772	.....	$37,605
1905	1,346	.....	5,199	.....	463,956	225,000	38,221
1906	1,994	413	11,265	.....	831,193	103,836	61,673
1907	2,048	13,741	8,633	.....	1,022,773	.....	73,646
1908	288	3	1,077	5,934	127,535	.....	6,713
1909	1,163	3,208	6,916	1,115	682,906	.....	36,314
1910	525	26	2,484	47	298,112	.....	14,490
1911	229	104	1,278	1,814	98,888	.....	5,458
1912	3,090	5,687	24,265	.....	827,556	458,594	89,493
1913	5,185	11,085	41,664	1,453	1,158,682	702,028	126,771
Increase (+)	+2,095	+5,398	+17,399	+1,453	+331,126	+243,434	+37,278

[1] Lindgren, Waldemar, op. cit., p. 176.
[2] Idem, pp. 39, 51–53, 57–58, 59, 60, 75, 176, 183–184.
[3] Idem, pp. 39, 57–58, 75, 175–179.
[4] Idem, pp. 19, 39, 57–58, 60, 66, 175–176, 179–182.

Luna County in 1913 produced 5,185 tons of lead and zinc carbonate and lead-zinc sulphide ores, containing $11,085 in gold; silver valued at $25,165; copper, at $225; lead, $50,982; and zinc, $39,314—a total of $126,771, as against $89,493 in 1912.

Cooks Peak district.[1]—A total of 1,271 tons of lead and zinc ore was shipped from this district in 1912, with a total value of $51,189. Lead-zinc sulphide, and lead and zinc carbonate ores, were shipped from the Summit group by lessees. Lead and zinc oxidized ores were shipped from the Desdemona, Contention, and Faywood mines.

Tres Hermanas district.[2]—A car of zinc carbonate ore was shipped from the Colebra mine.

Victorio (Gage) district.[3]—Lead carbonate ore was shipped from the Rambler, Helen, and Chance group mines.

OTERO COUNTY.

Mine production of gold, silver, copper, and lead in Otero County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	170	$1,050	$1,569	164	14,400	.....	$4,586
1905	117	1,036	41	93	53,602	.....	9,495
1906	268	195	228	533	133,166	.....	26,481
1907	12,203	100	14,711	2,135	679,480	.....	152,116
1908	22,418	1,475	34,215	4,351	723,907	.....	133,552
1909	143	100	157	29	6,354	.....	1,098
1910	2,545	6,022	2,559	2,046	49,874	6,046	16,286
1911	1,096	.....	6,718	715	22,730	739	9,971
1912	3,792	2,034	11,005	1,107	146,588	.....	37,907
1913	25,582	42	49,830	7,088	760,914	1,911	172,179
Increase (+) or decrease (−).	+21,790	−1,992	+38,825	+5,981	+614,326	+1,911	+134,272

The value of the mine production in 1913, in Otero County, from both deep and placer mines, was $172,179, of which $49,872 was for gold, $4,281 for silver, $117,942 for copper, and $84 for lead.

Highrolls (or Sacramento) district.—From 4 mines in this district there were produced 240 tons, yielding 30,524 pounds of copper, 308 ounces of silver, and $25 in gold. Producing mines were the Courtney, Old Reliable, and Sulphur Canon.

Jarilla (Orogrande, Silver Hill, Brice) district.[4]—Lode mines in the Jarilla district in 1913 produced 15,822 tons of ore, yielding $49,805 in gold, 6,444 ounces of silver, 597,580 pounds of copper, and 1,911 pounds of lead, with a total value of $146,406, as compared with $31,375 in 1912. In 1913 there was a nominal quantity of placer gold produced, as compared with an appreciable quantity in 1912. Producing mines were the Big Rock, By Chance, Delusion, Garnet, Lucky, and Nannie Baird. All the ore was shipped to smelters and was reported as sulphide in 1913, although reported in 1912 as part oxide and part sulphide, from these properties. Surface operations on the Mary H. placer yielded a nominal quantity of placer gold.

Tularosa district.[5]—The 150-ton concentration mill of the Tularosa Copper Co. was operated during part of the year on ore from the Vir-

[1] Lindgren, Waldemar, op. cit., pp. 37, 39, 62, 63, 64, 287–289.
[2] Idem, pp. 38, 41, 51, 55, 57, 58, 287, 292–295. Lindgren, Waldemar. The Tres Hermanas mining district, N. Mex.: U. S. Geol. Survey Bull. 380, pp. 123–128, 1909.
[3] Lindgren, Waldemar, U. S. Geol. Survey Prof. Paper 68, pp. 18, 43, 62, 63, 64, 287, 290–292, 1910.
[4] Idem, pp. 19, 35, 56, 60, 75, 184–187. Weed, W. H., op. cit., p. 118.
[5] Idem, pp. 77, 78, 184, 187–190, 1910.

ginia mine, the yield being copper concentrates, carrying a small quantity of silver.

RIO ARRIBA COUNTY.

Bromide district (Tusas).[1]—A small tonnage of ore, carrying silver, copper, and a little gold, was shipped from the Big Four Flush group.

Hopewell (Headstone) district.[2]—A small yield of placer gold was made from this district.

SANDOVAL COUNTY.

Cochiti (Bland) district.[3]—The Cossak Mining Co., in December, 1913, began the erection of an 100-ton custom cyanidation plant and began work on the Lone Star mine. The Lone Star mine is opened by a 950-foot adit. This district has not been active for 10 years. In the district are also the Crown Point mine, opened by a 250-foot incline shaft and 1,000 feet of drifts; the Washington, opened by a 250-foot shaft, 1,000 feet of drifts, and 200 feet of adits. The Albemarle, Iron King, and several other properties were producers from 1894 to 1904. In the 11 years from the opening of this district in 1894, when production began, to the close of 1904, the production had been slightly more than $1,000,000.

Cuba (Nacimiento Mountains) district.[4]—No work was done in this district.

Placitas district.[5]—No work was done in this district.

SAN MIGUEL COUNTY.

Tecolote district.[6]—A car of ore, carrying chiefly lead, but also silver, copper, and a little gold, was shipped from San Jose. Development work was continued on the Santo Nino mine, at Porvenir. There is a 20-ton concentration plant on the property.

SANTA FE COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Santa Fe County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	170	$4,135	$1,292	.....	2,308	.....	.....	$5,727
1905	180	4,002	2,241	42	.....	.....	.....	2,266
1906	128	6,737	7,143	53	.....	.....	.....	13,916
1907	21,338	1,231	16,748	17,635	1,231,260	.....	.....	275,870
1908	7	1,789	242	6	.....	.....	.....	2,034
1909	2,831	1,817	871	2,295	1,093	213,558	4,426	13,445
1910	4,739	4,262	3,877	3,359	5,150	262,023	74,759	26,173
1911	120	2,359	1,325	2,632	16,644	11,178	.....	7,663
1912	15,335	1,302	10,216	14,178	810,563	12,511	10,565	155,272
1913	29,800	129	26,746	22,076	1,798,769	794	.....	319,053
Increase (+) or decrease (−)	+14,465	−1,173	+16,530	+7,898	+988,206	−11,717	−10,565	+163,781

[1] Lindgren, Waldemar, U. S. Geol. Survey Prof. Paper 68, pp. 49, 50, 51, 124, 126, 130–133.
[2] Idem, pp. 27, 28, 49, 50–51, 75, 124–130.
[3] Idem, pp. 68, 69, 70, 71, 141, 150–158.
[4] Idem, pp. 77, 78, 143–147. Weed, W. H., op. cit., p. 118.
[5] Idem, p. 141, 1906.
[6] Idem, pp. 77, 109, 116–123.

The value of the mine production in Santa Fe County, from both placer and deep mines, was $319,053, for gold, silver, copper, and lead. Copper, however, was the most important metal produced.

Cerrillos district.[1]—Some development work was done, but no output was made in this district in 1913.

New Placers[2] *and San Pedro*[3] *districts.*—Oxidized ore was treated by amalgamation and sulphide ore was shipped from the Candelaria mine. After May, 1913, no ore was sold or treated, but ore was placed on dump in contemplation of the erection of a new mill. The 125-ton matting smelter of the Santa Fe Gold & Copper Co. was operated for 10½ months of the year, on ore from the company's mine and some custom ore from Colorado. There is no mill on this property. Several cars of copper ore, in small lots from various properties, were shipped from Golden. The output of placer bullion of the New Placers district, as handled by local merchants, dwindled to a nominal quantity in 1913.

SIERRA COUNTY.

Mine production of gold, silver, copper, and lead in Sierra County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	1,295	$22,979	$51,617	17,055	16,700	.....	$86,632
1905	3,516	47,878	51,164	8,760	46,664	.....	11,613
1906	3,246	1,509	16,539	8,102	5,995	.....	24,633
1907	700	595	7,629	2,250	5,425	9,548	11,300
1908	680	1,979	16,039	8,589	12,874	6,075	24,524
1909	4,294	.....	10,450	25,698	25,838	49,023	29,280
1910	8,306	584	11,113	15,778	2,448	11,274	21,024
1911	5,036	823	26,962	16,487	5,374	28,088	38,459
1912	252	1,546	2,597	11,236	8,988	21,001	13,481
1913	269	423	434	2,529	2,568	32,685	4,221
Increase (+) or decrease (−)	+17	−1,123	−2,163	−8,707	−6,420	+11,684	−9,260

The value of the mine production in 1913 in Sierra County, from both deep and placer mines, was $4,221, as compared with $13,481 in 1912.

Caballos Mountains district.[4]—A small lot of lead ore from the Gladys mine and several cars of lead ore from the Vanadium Mines Co.'s property were shipped.

Chloride (Apache, Cuchillo Negro) district.[5]—Development work was done on the Silver Monument mine and a small tonnage of ore was milled at the 30-ton concentration plant on the property.

Hermosa district.[6]—No production was made in this district in 1913.

Hillsboro (Las Animas) district.[7]—A small shipment of copper ore was made from the Wicks Gulch mine. Placer gold was recovered from the Luxemburg placer by the use of the Quenner trommel mill

[1] Clark, F. W., and Diller, J. S., Turquoise from New Mexico: U. S. Geol. Survey Bull. 42, p. 39, 1887. Lindgren, Waldemar, U. S. Geol. Survey Prof. Paper 68, pp. 35, 36, 39, 57, 58, 60, 163–167, 1910.
[2] Lindgren, Waldemar, op. cit., pp. 17, 75, 76, 163, 164, 170–175.
[3] Idem, pp. 51–53, 55, 57–58, 60, 62, 64, 171–174.
[4] Hess, F. L., Vanadium in the Sierra de los Caballos, New Mexico: U. S. Geol. Survey Bull. 530, pp. 157–160, 1912.
[5] Lindgren, Waldemar, U. S. Geol. Survey Prof. Paper 68, pp. 27, 28, 29, 30, 74, 218, 229, 238, 283–285, 1910.
[6] Idem, pp. 18, 55, 62–67, 77, 218, 232, 233, 267–268.
[7] Idem, pp. 18, 30, 31, 37, 39, 43, 62, 64, 65, 68, 69, 70, 75, 214, 218, 227–228, 238, 239, 272–276, 277. Weed, W. H., op. cit., p. 118.

and the dry concentrator of the Hilltscher Bros.[1] There was a small output from placers operated by Mexicans.

Kingston (Black Range) district.[2]—Various small lots of ore were shipped from this district.

Tierra Blanca (Bromide No. 1) district.[3]—Development work was done on the Midnight, Argus, and other claims of the Bi-Metallic Co.

SOCORRO COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Socorro County, N. Mex., 1911–1913.

Year.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*	
1911	25,844.49	$534,253	1,109,945	$588,271
1912	25,427.30	525,629	1,126,439	692,754
1913	30,179.04	623,856	1,347,160	813,685
Increase (+)	+4,751.74	+98,227	+220,721	+120,931

Year.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
1911	79,321	$9,915	2,124,901	$95,621	9,930,281	$566,026	$1,794,086
1912	89,776	14,813	2,193,178	98,693	9,962,478	687,411	2,019,200
1913	289,566	44,883	2,199,247	96,767	13,267,811	742,997	2,322,188
Increase (+) or decrease (−)	+199,790	+30,070	+6,069	−1,926	+3,305,333	+55,586	+302,888

Cooney (Mogollon) district.[4]—The production of the Mogollon district in 1913 was 115,739 tons of ore, yielding $619,886 in gold 1,306,766 ounces of silver, and a nominal quantity of copper and lead, with a total value of $1,409,912, an increase of $212,715. The value of gold showed an increase of $95,028, and the value of silver production an increase of $116,995. The gold output of this district represented 70 per cent of the State yield of this metal, and the silver yield, 80 per cent of the total silver output. The greater part of the copper was contained in a small shipment of crude ore to smelter, the remainder of the copper and all the lead being in concentrates.

There were 8 producing mines in the district, as against 11 in 1912, but the tonnage increased from 101,361 tons to 115,739 tons. The average assay per ton in terms of recovered metal was 0.2591 ounce or $5.356 in gold, and 11.29 ounces or $6.82 in silver.

The Deadwood 15-stamp 70-ton concentration-cyanidation mill, with increased leaching and slime plant in 1913, was used to treat custom ore from the Little Charlie, Pacific, and Trilby mines, as well as ore from the company's Deadwood mine. The Ernestine concen-

[1] For discussion of dry placers in the United States see Heikes, V. C., and Yale, Charles G., U. S. Geol. Survey, Mineral Resources, 1912, pt. 1, pp. 255–262, 1913.

[2] Harder, E. C., Manganese deposits of the United States: U. S. Geol. Survey Bull. 380, p. 274, 1909. Lindgren, Waldemar, U. S. Geol. Survey Prof. Paper 68, pp. 18, 31, 34, 37, 62, 65, 218, 224, 225, 226, 228, 232, 245, 268–270, 1910.

[3] Lindgren, Waldemar, op. cit., pp. 37, 64, 66, 218, 268–271.

[4] Lindgren, Waldemar, op. cit., pp. 18, 42, 43, 44, 47, 68, 69–71, 191–204.

tration-cyanidation mill with a capacity of 160 tons per day in 1913, as compared with 110 tons in 1912, was operated continuously and an increased tonnage was treated. Ore treated was from the company's Last Chance and Top mines and also custom ore from the Maud S. and Pacific mines. The Fanny or Socorro Mining & Milling Co.'s 30-stamp 195-ton concentration-cyanidation mill was used to treat ore not only from the company's mines but also from the Johnson and East End tunnel group of the Oaks Co., the Little Charlie, the Pacific, and the Craig mines. The Treasure mill was idle. A small shipment of copper ore was made from the Little Charlie mine. The mine reports indicate that the ore is siliceous, both oxide and sulphide, and that oxidization extends from 700 to 1,200 feet.

Production of Cooney or Mogollon district, Socorro County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	11,276	$61,880	79,014	422,308	.....	$162,484
1905	15,534	97,158	240,943	295,175	.....	288,735
1906	16,076	127,907	268,567	.....	.....	307,847
1907	20,698	105,413	418,338	150,000	.....	411,516
1908	19,546	116,418	278,939	.....	.....	264,256
1909	23,945	111,464	249,413	46	49	241,167
1910	50,514	301,210	595,669	.....	.....	625,871
1911	102,219	531,358	1,067,038	1,873	1,862	1,097,206
1912	101,361	524,858	1,093,158	184	386	1,197,197
1913	115,739	619,886	1,306,766	4,418	1,217	1,409,912
Increase (+)	+14,378	+95,028	+213,608	+4,234	+831	+212,715

Magdalena (Kelly) district.[1]—There were increases in 1913 in the yield of all the metals, particularly of zinc, the chief metal produced in this district, which increased from 9,962,478 pounds to 13,267,811 pounds.

Production of Magdalena district, Socorro County, N. Mex., 1904–1913.

Year.	Tonnage.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	27,998	$154	5,024	3,200	688,209	17,991,780	$932,658
1905	30,411	.....	4,800	320,000	390,000	14,630,051	934,322
1906	35,478	.....	2,515	64,560	238,088	17,044,163	1,067,410
1907	3,630	13	4,406	24,045	707,981	676,356	85,158
1908	6,319	72	460	2,605	16,073	3,325,446	157,631
1909	30,724	435	17,925	170,792	3,085,279	12,878,241	860,051
1910	42,232	468	65,800	152,181	3,451,228	16,727,870	1,110,529
1911	25,840	352	42,773	77,448	2,123,039	9,930,281	694,266
1912	22,590	746	32,792	69,532	2,192,792	9,962,478	818,473
1913	47,647	3,942	40,212	278,252	2,198,030	13,267,811	911,069
Increase (+)	+25,057	+3,196	+7,420	+208,720	+5,238	+3,305,333	+92,596

Zinc carbonate ore was shipped from the Ambrosia mine. Copper-lead and lead ores were shipped from the Germany mine. A large tonnage of lead oxide and zinc carbonate ores was shipped from the Juanita mines. From February, 1913, throughout the year, the new 150-ton concentration mill (with special finishing process) of

[1] Dutton, C. E., Mount Taylor and the Zuni Plateau: U. S. Geol. Survey Sixth Ann. Rept, p. 194, 1885; Lindgren, Waldemar, op. cit., pp. 18, 19, 47, 51–53, 55, 214, 218, 220, 241–258; Weed, W. H., op. cit., p. 118.

the Ozark Co. was operated almost continuously, reaching a daily capacity of 125 tons. Zinc concentrates were shipped to various zinc smelters and zinc oxide plants. Also crude copper sulphide, copper oxidized, lead sulphide, lead oxidized, zinc sulphide, zinc-lead oxidized, and zinc carbonate ores, in considerable quantities, were shipped to smelters. The mine and 60-ton magnetic separation and wet-concentration mill of the Tri-Bullion Co. were operated only six months of the year, before being closed. Lead, iron, and zinc concentrates were the product from the mill, and zinc carbonate, lead carbonate, and copper sulphide ores were shipped direct from mine to smelters. This property, including the mill, was later purchased by the Empire Zinc Co., which has made various changes in the mill. According to the report of the Tri-Bullion Smelting & Development Co. for the year ending October 31, 1913:

> The company * * * decided to sell the Kelly group of claims, and a sale was consumated at $87,500. * * * Since the sale of this property the company now owns about 112 acres of copper-zinc claims at Kelly. * * *
>
> The production during the period covered by the report amounted to 2,572 tons of zinc concentrates, 1,467 tons of lead concentrates, 2,096 tons of iron middlings, 1,505 tons of copper ore, 417 tons of zinc carbonates, 137 tons of zinc sulphides, and 45 tons of lead carbonates. The value of this product by smelter settlements was $153,861, but after payment of operating charges, there was a net loss of $21,678. Development charges at Kelly, amounting to $28,208, increased the charges to $49,886 above income.[1]

A small tonnage of copper ore was shipped from the Wheel of Fortune mine.

San Andreas Mountains (Hembrillo) district.[2]—A small tonnage of copper ore was shipped from the St. Lawrence mine.

TAOS COUNTY.

Red River district.[3]—Oxidized gold and silver ore from the Caribel and Memphis mines was milled at the Trinidad Mining & Milling Co.'s June Bug 10-ton cyanidation mill (built in 1900). This mill has the following equipment: One Dodge crusher, 8-foot Elspass mill, two 5-ton agitating tanks. A 5-stamp cyanidation mill was was built on the Caribel property.

Rio Hondo district.[4]—No work was done in this district in 1913.

---

[1] See Eng. and Min. Jour., July 18, 1914, pp. 119-120.
[2] Lindgren, Waldemar, op. cit., pp. 35, 74, 205, 234.
[3] Idem, pp 35, 36, 42, 43, 68, 69, 70, 71, 82, 84–88.
[4] Idem, pp. 75, 83, 84.

TEXAS.[1]

PRODUCTION.

The following table shows the production of gold, silver, copper, lead, and zinc in Texas in 1912 and 1913:

Production of gold, silver, copper, lead, and zinc in Texas in 1912 and 1913.

Year.	Gold.		Silver.		Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Pounds.*		*Pounds.*		*Pounds.*		
1912	3.05	$63	406,067	$249,731	721	$119	65,311	$2,939	238,000	$16,422	$269,274
1913	16.45	340	427,553	258,242	34,665	5,373	225,227	9,910	652,607	36,546	310,411
Increase (+).	+13.40	+277	+21,486	+8,511	+33,944	+5,254	+159,916	+6,971	+414,607	+20,124	+41,137

The output of Texas mines during 1913 was $340 for gold, 427,553 fine ounces of silver, 225,227 pounds of lead, 34,665 pounds of copper, and 652,607 pounds of zinc (figured as spelter recovered); with a total value of $310,411, as compared with $269,274 in 1912. The greater part of the silver output came from the Shafter district, Presidio County, from the Presidio silver mine and mill. The Presidio mill, operated since 1885 as a 70-ton pan-amalgamation mill, was changed during 1913 to a 140-ton all-sliming, continuous agitation, and filtration cyanide plant. The copper came chiefly from several properties in the Van Horn district, Culberson County. In this district the old Hazel mine was reopened and a considerable tonnage of highly siliceous sandstone, carrying sulphides of silver and copper, was separated by the Sutton, Steele & Steele dry concentrator and static electric separator. The lead and zinc yield came from the Sierra Blanca district.

TOTAL PRODUCTION OF TEXAS.

The following table gives the total production of Texas of gold, silver, copper, lead, and zinc from 1885 to 1913, inclusive:

[1] For discussion of the geology of the districts mentioned in the following pages the reader is directed to the bibliography appended to the report for 1912, in Mineral Resources, 1912, pt. 1, pp. 876–7, 1913, and to Survey Bulletin 507: The mining districts of the western United States, by J. M. Hill, with a geological introduction by Waldemar Lindgren, 1912.

Production of gold, silver, copper, lead, and zinc in Texas, 1885–1913.

Year.	Gold.	Silver.		Copper.		Lead.		Zinc.		Total. value (commercial).
		Fine ounces.	Commercial value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	
1885 [a]	.....	[be] 169,342	[c] $181,196	.....	.....	.....	.....	.....	.....	$181,196
1886	.....	[be] 191,873	[d] 189,954	.....	.....	.....	.....	.....	.....	189,954
1887	.....	[bf] 235,999	231,279	(g)	.....	.....	.....	.....	.....	231,279
1888	.....	[h] 380,068	357,264	.....	.....	.....	.....	.....	.....	357,264
1889	[i] $6,828	[i] 323,438	304,032	.....	.....	.....	.....	.....	.....	310,860
1890	[j] 78	[j] 370,000	388,500	(j)	.....	(j)	.....	.....	.....	388,578
1891	.....	[k] 375,000	371,250	[l] 42,000	$5,376	[l] 7,385	$318	.....	.....	376,944
1892	.....	[m] 328,100	285,447	.....	.....	.....	.....	.....	.....	285,447
1893	[o] 2,662	[n] 349,400	272,532	.....	.....	.....	.....	.....	.....	275,194
1894	[no] 4,320	[n] 429,314	270,468	.....	.....	.....	.....	.....	.....	274,788
1895	.....	[n] 450,000	292,500	.....	.....	.....	.....	.....	.....	292,500
1896	[n] 8,000	[n] 525,400	357,272	.....	.....	(y)	.....	.....	.....	365,272
1897	[n] 7,400	[n] 404,700	242,820	.....	.....	(y)	.....	.....	.....	250,220
1898	[n] 300	[n] 472,900	279,011	.....	.....	(y)	.....	.....	.....	279,311
1899	[n] 6,900	[n] 520,000	312,000	.....	.....	(y)	.....	.....	.....	318,900
1900	[n] 1,100	[n] 477,400	295,988	.....	.....	.....	.....	.....	.....	297,088
1901	[n] 600	[n] 472,400	283,440	.....	.....	(y)	.....	.....	.....	284,040
1902	.....	[n] 446,200	236,486	.....	.....	(y)	.....	.....	.....	236,486
1903	.....	[n] 454,400	245,376	.....	.....	(y)	.....	.....	.....	245,376
1904	[pq] 186	[pq] 385,576	223,634	.....	.....	(y)	.....	.....	.....	223,820
1905	[pr] 248	[pr] 387,506	236,379	.....	.....	.....	.....	.....	.....	236,627
1906	[ps] 1,592	[ps] 301,772	205,205	.....	.....	[p] 49,030	2,795	[z] 16,000	$976	210,568
1907	[pt] 9	[pt] 303,688	200,434	.....	.....	[p] 23,947	1,269	[p] 44,000	2,596	204,308
1908	(pu)	[pu] 444,336	235,498	[p] 98,364	3,744	[p] 65,833	2,765	[p] 35,957	1,690	243,697
1909	[pv] 314	[pv] 374,444	194,711	[p] 3,862	502	[p] 91,140	3,919	.....	.....	199,446
1910	[pw] 423	[pw] 380,322	205,374	[p] 3,157	401	[p] 65,068	2,863	.....	.....	209,061
1911	[px] 21	[px] 424,394	224,929	.....	.....	[p] 122,800	5,526	.....	.....	230,476
1912	[p] 63	[p] 406,067	249,731	[p] 721	119	[p] 65,311	2,939	[p] 238,000	16,422	269,274
1913	[p] 340	[p] 427,553	258,242	[p] 34,665	5,373	[p] 225,227	9,910	[p] 652 607	36,546	310,411
Total	41,384	11,211,592	7,630,952	112,769	15,515	715,741	32,304	986,564	58,230	7,778,385

[a] U. S. Geol. Survey, Mineral Resources, 1908, p. 541, 1909, and idem, 1910, Pt. I, p. 572, 1911. Report from Presidio Mining Co. says "mine operated continuously since 1884." Company report (1908) also says "mill was started Dec. 25, 1885, and operated steadily to date."

[b] Report of Director of the Mint for 1887, p. 238, being the report of Francis N. Holbrook, agent for the mint.

[c] U. S. Geol. Survey, Mineral Resources, 1885, p. 201, gives $90,000 for combined production of Texas, Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming.

[d] U. S. Geol. Survey, Mineral Resources, 1886, p. 105, gives $205,000 for combined production of Texas, Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming.

[e] Phillips, W. B., The Mineral Resources of Texas: Texas Dept. of Agr. Bull. 14, July–August, 1910, p. 22; gives 155,039 fine ounces, valued at $154,263, for 1882–1886.

[f] Rept. Director of the Mint estimate for 1887 is 193,364 ounces, valued at $250,000; U. S. Geol. Survey, Mineral Resources, 1887, the same; Phillips, op. cit., gives 193,798 ounces.

[g] Mint agent says (pp. 237–238): "Ores of the Carrizo district (near Van Horn, Culberson County) * * * average about 54 ounces silver per ton and 6 to 20 per cent copper. Mines actually worked and shipping ore—Hazel, Sancho Panza, Llewellyn, Gracie."

[h] Holbrook, Rept. Director of Mint for 1888, pp. 22, 155. Director of Mint gives 232,031 ounces (p. 22), but gives the same (232,031 ounces) for 1889, p. 21.

[i] U. S. Geol. Survey, Mineral Resources, 1889–1890, p. 49, being Eleventh Census figures. Director of the Mint for 1889 gives 232,031 ounces; mint agent gives 310,007 ounces; Phillips, 324,165 ounces.

[j] Yale, Chas. G., mint agent, Rept. Director of the Mint for 1890, pp. 20, 180, gives: Presidio mine, 5,596 tons, 163,952 ounces silver; Cibolo Creek, 4,618 tons, 119,071 ounces silver; Hazel, $83,000 silver, some copper. Chaouti (Chinati?) mine (at Shafter) shipped 22,750 pounds of ore, averaging 26 ounces silver, ¾ ounce gold, 31 per cent lead. Mentions Bonanza mine (Sierra Blanca district, El Paso County). Rept. Director of the Mint, p. 21, and U. S. Geol. Survey, Mineral Resources, 1889–1890 give 300,000 ounces; Phillips, 300,690 ounces.

[k] Director of the Mint, U. S. Geol. Survey, Mineral Resources, 1891, and Phillips for 1891.

[l] Mint agent, Rept. Director of the Mint, p. 220, gives 357,370 ounces silver, 42,000 pounds of copper (from 600 tons of ore from Hazel mine) and 7,358 pounds of lead (from 10.8 tons of ore from Bonanza mine).

[m] U. S. Geol. Survey, Mineral Resources, 1893, p. 50, also Rept. Director of the Mint for 1893, p. 19, and subsequent reports. U. S. Geol. Survey, Mineral Resources, 1892, and mint for 1892 give 310,000 ounces.

[n] U. S. Geol. Survey, Mineral Resources, 1894, being estimate by Director of the Mint. Mint agent's figures for these years correspond closely with director's figures.

[o] Agent's figures, Director of the Mint.

[p] U. S. Geol. Survey, Mineral Resources, 1904. Collected from the mines.

[q] Director of the Mint gives $2,300 gold and 469,600 ounces of silver.

[r] Director of the Mint gives $1,900 gold and 417,200 ounces of silver.

[s] Director of the Mint gives $3,400 gold and 277,400 ounces of silver.

[t] Director of the Mint gives $1,000 gold and 305,300 ounces of silver.

[u] Director of the Mint gives $500 gold and 447,000 ounces of silver.

[v] Director of the Mint gives $400 gold and 408,100 ounces of silver.

[w] Director of the Mint gives $400 gold and 364,400 ounces of silver.

[x] Director of the Mint gives $3,900 gold and 444,200 ounces of silver.

[y] Included with Washington, Oregon, Alaska, and South Dakota for 1896, 1897, 1898, 1899, 1901. Included with Oregon, Alaska, and South Dakota for 1902, 1903, and 1904.

[z] Smelter figures.

REDUCTION MILLS.

Mineral Resources for 1912, part 1, page 879, 1913, contained a complete list of the reduction mills in Texas in 1912, with description of equipment and process. Any changes in this list for 1913 have been noted in the text of the various counties, and reference should be made to the 1912 report for details of equipment.

REVIEW BY COUNTIES.[1]

BREWSTER COUNTY.

A little prospecting was done near Alpine in 1913. In this district are the Caruthers prospect and the Bird mines. From the latter in the past, some silver-bearing galena has been shipped to the El Paso smelter.[2]

BURNET COUNTY.

Prospecting was done in 1913 near Burnet. It is reported that copper, lead, and zinc minerals have been found in the district.[3]

CULBERSON COUNTY.

The mining districts of Culberson County were included in El Paso County before 1911. Shipments of crude ore and concentrates of the same ore, separated by the Sutton, Steele & Steele dry concentrator and static dielectric separator on the property, were shipped from the Hazel mine. This mine, in pre-Cambrian sandstone,[4] has been an important producer of silver-copper ore.[5] A small shipment of silver-copper ore was made from the Tres Hermanos mine, and a shipment of silver-lead-copper ore was made from the Pecos mine.

EL PASO COUNTY.

In the Sierra Blanca district, the 75-ton concentration plant (1 crusher, 2 sets rolls, screens, and 2 jigs), of the Southwestern Mines Co., on the Bonanza property,[6] was operated during a part of the year, yielding a lead and a zinc concentrate.

KNOX COUNTY.

Work was abandoned on the copper prospects, near Truscott, in the blue clays of the Permian beds.[7]

---

[1] In this section references to discussions of the geology of the several districts are given in the footnotes.
[2] Phillips, W. B., Lead ore in Burnet County, Tex., Eng. and Min. Jour., vol. 77, p. 364, 1904.
[3] Phillips, W. B., op. cit., p. 394.
[4] Richardson, G. B., Reconnaissance of trans-Pecos Texas: Texas Univ. Mineral Survey Bull. 9, pp. 24–25, 1904.
[5] Von Streeruwitz, Trans-Pecos Texas: Texas Geol. Survey, Third Ann. Rept., pp. 387–389, 1892. Von Streeruwitz, Report on the geology and mineral resources of trans-Pecos Texas: Texas Geol. Survey, Second Ann. Rept., p. 699, 1891.
[6] Von Streeruwitz, W., Geology of trans-Pecos Texas: Texas Geol. Survey, First Ann. Rept. pp. 223–224, 1890.
[7] Cummins, W. F., Notes on the geology of Northwest Texas: Texas Geol. Survey, Fourth Ann. Rept., pp. 232–238, 1893.
Phillips, W. B., Texas Geol. Survey, Second Ann. Rept., p. 450, 1890.
Phillips, W. B., The Permian copper ores in Texas: Eng. and Min. Jour., pp. 1181–1182, Dec. 16, 1911.

LLANO COUNTY.[1]

At the Heath mine,[2] near Llano, only experimental work was done at the mill (an amalgamation-concentration plant), and early in 1914 excavation and foundations were made for a cyanide plant of 50 tons capacity, to consist of Dorr agitators, thickeners, and classifiers.

PRESIDIO COUNTY.

Shafter district.[3]—The greater part of the total silver output of Texas has come from the Shafter district, and chiefly from the Presidio mine, which has been operated steadily since 1884. The ore, which is chiefly silver chloride (horn silver) with which are associated more or less isolated patches of silver-bearing galena, has been treated since 1884 by pan-amalgamation, but in May, 1913, the mill was reconstructed into a cyanide plant, using the all-sliming process and continuous agitation and filtration, with an increase in capacity from 100 to 140 tons.

---

[1] Auriferous and argentiferous copper ore in Llano County: Am. Inst. Min. Eng. Trans., vol. 5, p. 16, 1876-7. Comstock, T. B., Report on the geology and mineral resources of the central region of Texas: Texas Geol. Survey 2d Ann. Rept., pp. 577-582, 1891. Also preliminary report on the geology of the central mineral region of Texas: Texas Geol. Survey 1st Ann. Rept., pp. 334-339, 1890. Dumble, E. T., The occurrence of gold in the Eocene deposits of Texas: Am. Inst. Min. Eng. Trans., vol. 44, 1912, or Bull. 70, October, 1912, and Eng. and Min. Jour., p. 836, Nov. 2, 1912. Hess, Frank L., Minerals of the rare-earth metals at Baringer Hill, Llano County, Tex.: U. S. Geol. Survey, Bull. 340, pp. 286-294, 1908. Paige, Sidney, Preliminary report on pre-Cambrian geology and iron ores of Llano County, Tex.: U. S. Geol. Survey, Bull. 430, pp. 256-268, 1910. Paige, Sidney, Mineral resources of Llano-Burnet region, Texas: U. S. Geol. Survey, Bull. 450, 1911. Paige, Sidney, U. S. Geol. Survey, Geol. Atlas, Llano-Burnet folio (No. 183), 1912.

[2] McLaren, A., Gold and rare metal mining near Llano, Tex.: Salt Lake Min. Rev., vol. 14, No. 3, pp. 11-13, May 15, 1912. Paige, Sidney, U. S. Geol. Survey, Bull. 450, pp. 70-72, 1911. Paige, Sidney, U. S. Geol. Survey, Geol. Atlas, Llano-Burnet folio (No. 183), p. 13, 1912.

[3] Phillips, W. B., Shafter silver district, Presidio County, Tex.: Eng. and Min. Jour., p. 1303, Dec. 31, 1910. Udden, J. A., The geology of the Shafter silver mine district, Presidio County, Tex.: Texas Univ. Mineral Survey, Bull. 8, p. 54, 1904.

PLATINUM AND ALLIED METALS.

By David T. Day.

PLATINUM.

INTRODUCTION.

The platinum industry remains practically stationary with reference to the world's supply and the price.

The supply from the well-known placers of Russia continues to decline slowly, but the uses for platinum do not increase sufficiently to cause the price to advance on account of the decline in supply. If more platinum were greatly needed, the supply could be augmented from California and Oregon.

DOMESTIC PRODUCTION.

CRUDE PLATINUM.

Although the high price of platinum encouraged prospecting in the United States during 1913, the expected increase in the production of crude metal was not realized. The total production from California and Oregon amounted to 482.87 crude ounces and was valued at $18,477. Of this, 460.37 crude ounces came from California and were rated at 80 per cent fine—that is, it contained 368.3 fine ounces of platinum. That from Oregon—22.5 ounces—was not so carefully cleaned and was reckoned at 70 per cent fine, or 15.75 fine ounces of platinum. The greater part of the California platinum came, as usual, from the large gold-dredging operations in Butte, Yuba, Sacramento, and Calaveras counties.

The question of a larger yield of domestic platinum depends principally upon working the Oregon and California beaches, including the old beaches now several miles inland and elevated considerably above sea level. Several machines involving somewhat fanciful or novel ideas were installed during 1913, as reported in the last review of this series. As a rule these machines were handicapped because they consisted either of competent concentrating apparatus without adequate means for digging the crude sand and delivering it to the concentrator, or, in other places, the reverse has been the case, and the machine, well suited for large-scale excavation at a low cost, has not been equipped with a proper system for cencentrating these heavy sands after excavating them.

A sample of heavy concentrates from placer mining near Yacolt, Wash., on examination showed small quantities of gold and about one-sixth as much platinum as gold. No gold or platinum was found in any of the sand coarser than 100 mesh.

REFINED PLATINUM.

A considerable output of platinum is annually made in the United States from the refining of gold and copper bullion. A portion of this platinum originates in old scrap, sweepings, etc., sold by jewelers and dentists. About 650 fine ounces, however, was derived in 1913 as new metal from gold and copper bullion from domestic mines. No output of platinum concentrates was reported from platiniferous lodes of the United States in 1913.

In 1913 crude platinum sand was imported into the United States to the amount of 48,942 ounces. If the content of fine platinum in this sand is assumed to be 80 per cent, the approximate production of refined platinum in the United States in domestic refineries from foreign sands in 1913 was 39,154 ounces.

Production of refined platinum from domestic sources, 1903–1913, in troy ounces.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	110	$2,080	1909	638	$15,950
1904	200	4,160	1910	773	25,277
1905	318	5,320	1911	940	40,890
1906	1,439	45,189	1912	1,005	45,778
1907	357	10,589	1913	1,034	46,530
1908	750	14,250			

PRICES.

The following table gives the prices of ingot platinum per troy ounce at New York, by months, for the calendar years 1909–1913:

Prices of ingot platinum per troy ounce on the New York market,[1] 1909–1913, by months.

1909.

January	$24.25	July	$22.50
February	24.50	August	22.00
March	23.75	September	25.50
April	24.00	October	28.00
May	23.50	November	29.25
June	23.00	December	29.50

1910.

January	$29.00	July	$33.00
February	28.75	August	33.00
March	29.13	September	33.63
April	29.25	October	37.50
May	29.55	November	39.44
June	31.38	December	38.75

[1] Eng. and Min. Jour., New York.

1911.

January	$39.03	July	$42.98
February	39.35	August	44.35
March	41.02	September	45.32
April	41.33	October	46.22
May	48.85	November	46.10
June	42.86	December	46.05

1912.

January	$46.00	July	$45.50
February	45.63	August	45.50
March	45.50	September	45.50
April	45.50	October	45.50
May	45.50	November	45.50
June	45.50	December	45.50

1913.

January	$45.50	July	$45.50
February	45.50	August	44.90
March	45.50	September	43.96
April	45.50	October	44.00
May	45.50	November	43.70
June	45.50	December	43.45

Price of crude platinum sand.—For many years quotations for crude platinum sand have varied within wide limits, so as to leave much doubt in the minds of the producers of platinum and osmiridium as to what they should justly receive for their product. This fluctuation has been due to two factors, the principal one being the wide variation in the quality of the sand sent in for sale. As a rule it contains some magnetic ore or valueless grains of sand, and the grains of the metal itself are impure, containing iron, gold, and silver. Exception is made for the gold, but payment is not made for any other material. In order to determine a fair return for samples of sand sent in for sale, the Geological Survey divided a sample of crude platinum sand obtained from the Coos Bay region of Oregon into several lots, and sent them to as many different platinum purchasers, with the request for bids on the material. The bids were uniformly between $41 and $42 an ounce for the pure metal contained in the sand. The analyses of the sand by these purchasers were fairly uniform in their results, showing from 48 to 50 per cent of valuable metals in the said. The valuable metals averaged about 33 per cent platinum and 17 per cent osmiridium and gold (or about 50 per cent of each sample), making the value of this sand as sampled about $21 per ounce.

In regard to the price of the osmiridium, or iridosmine, contained it should be noted that this is frequently called "iridium" by the miners. Pure iridium would be worth much more than platinum because of its scarcity and its value for alloying with platinum to increase its hardness. As elsewhere stated in this report, iridosmine (or osmiridium) is not pure iridium, but contains from 30 to 50 per cent or more of osmium, which is of little value.

OCCURRENCE OF PLATINUM IN LODE DEPOSITS.

DEPOSITS PREVIOUSLY KNOWN.

Although the world's supply of platinum comes mainly from placer gravels, this metal is known to occur in lode deposits, chiefly associated with iron and copper sulphides and probably of magmatic origin. In the nickel deposits of Sudbury, Ontario, platinum arsenide (sperrylite, $PtAs_2$) is found as small white cubes, with chalcopyrite and pyrrhotite. Sperrylite is also known from the Rambler mine in Wyoming, where it is associated with the copper ores, chalcopyrite and covellite, probably of igneous origin and forming a lens in a dioritic rock. There has been some commercial output of platinum concentrates from this mine. Palladium is also present. Platinum, perhaps also as sperrylite, is found in dikes of peridotite at Bunkerville, Nev., cutting pre-Cambrian gneiss, associated again with chalcopyrite and pyrrhotite. Platinum has been reported with wollastonite and grossularite garnet in a contact metamorphic rock in Sumatra, and in quartz veins from southern New Zealand, northern Finland, and Canada. Palladium has been found with gold in a limestone in Brazil near the contact with an igneous rock, and this alloy has also been reported in both placer and lode deposits in the Kongo Free State. The gravel platinum of the Pacific coast is probably derived from serpentine masses of the Sierra Nevada.

PLATINUM LODE DEPOSIT AT GOODSPRINGS, NEV.

In August, 1914, while this chapter was in proof, a new discovery of platinum in lode deposits was reported to the United States Geological Survey, and efforts were made by the Survey to obtain some reliable preliminary data for inclusion herewith in view of the threatened shortage of Russian supplies due to the European war. For the information following, thanks are due to Mr. Fred. A. Hale, jr., secretary of the Boss Gold Mining Co., of Goodsprings, Nev., upon whose property the discovery was made. A geologic investigation of the occurrence during the present field season is in prospect by the Survey.

The property upon which the discovery was made is located about 10 miles west of Goodsprings, and development work has disclosed a considerable body of siliceous ore, carrying copper, gold, silver, and platinum, occurring along a fractured zone in limestone and adjacent to a large intrusion of quartz monzonite porphyry. Some very rich ore has been reported, and at least 2,000 tons of ore carrying 1 ounce of gold to the ton, with associated silver and platinum, were estimated to be in sight in August. One carload of 23 per cent copper ore was shipped, and a small shipment of gold ore averaging 124.8 ounces of gold per ton was made. Later other small shipments of high-grade ore, and a 40-ton car of ore assaying about 15 ounces of gold to the ton, were also reported. Numerous assays indicated that the high-grade gold ore carried as high as 65 ounces and the low-grade about 1 ounce of platinum per ton.

A general average sample of ore exposed at the mine, assayed by the Union Assay Office, of Salt Lake City, Utah, is reported to have given the following results:

Analysis of average sample of ore from Boss Gold Co.'s mine at Goodsprings, Nev.

Gold	ounces per ton	6.72
Silver	do	9.7
Platinum group	do	.78
Insoluble	per cent	75.7
Iron	do	9.4

From similar material H. K. Riddall, chemist for the Yellow Pine Mining Co., Goodsprings, Nev., obtained 1.2 ounces of platinum per ton, and R. A. Perez, of Los Angeles, Cal., 1 ounce of platinum per ton.

Two grab samples from a carload lot shipment gave Mr. Riddall the following results:

Partial analysis of samples of ore from Boss Gold Co.'s mine at Goodsprings, Nev.

	Ounces per ton of ore—	
	1	2
Gold	6.7	16.26
Platinum	8.53	11.42

From similar material sent to Ledoux & Co., New York City, for determination, the following results were reported: Gold, 11.55 ounces per ton; platinum, 7.38 ounces per ton. The determination of palladium was not made; but the presence of this metal was reported by Ledoux to the extent of 1 to 2 ounces per ton.

A small shipment of high-grade ore assayed as follows:

Analysis of high-grade ore from Boss Gold Co.'s mine, Goodsprings, Nev.

Gold	ounces per ton	118.17
Silver	do	25.4
Lead	per cent	1.0
Copper	do	.65
Insoluble	do	73.2
Sulphur	do	3.1
Iron	do	6.7

No determination of platinum was reported upon by the smelting company, but Mr. Riddall obtained 65 ounces per ton of metal of the platinum group from this material. A second lot of similar high-grade ore yielded the following assay by the smelting company:

Analysis of high-grade ore from Boss Gold Co.'s mine, Goodsprings, Nev.

Gold	ounces per ton	117.66
Silver	do	6.9
Platinum group		Not determined.
Lead	per cent	1.7
Copper	do	.55
Insoluble	do	63.0
Sulphur	do	2.6
Iron	do	6.6
Bismuth	do	1.3

On a sample of similar material sent to Ledoux & Co. that firm reported as follows:

Analysis of ore from Boss Gold Co.'s mine, Goodsprings, Nev.

Gold	ounces per ton 111.00
Platinum	do 99.08
Palladium	do 16.00
Iridium	Not determined but present in small quantities.

It should be added that both samples sent to Ledoux & Co. showed by panning, according to their report, that the gold and platinum metals are in the free state and occur apparently as alloys.

IMPORTS.

The following table shows the imports for consumption into the United States of platinum in 1904–1913:

Platinum imported for consumption into the United States, 1904–1913.

Year.	Platinum or crude platinum, and unmanufactured products, ingots, bars, sheets, and wires.		Manufactured products, including vases, retorts, etc.	Total value.
	Quantity.	Value.		
	Troy ounces			
1904				$1,879,155
1905	93,912	$1,985,107	$188,156	2,173,263
1906	137,928	3,601,120	187,639	3,788,759
1907	74,292	2,508,991	175,651	2,684,642
1908	50,844	1,095,754	134,119	1,229,873
1909	118,853	2,557,596	416,352	2,973,948
1910	118,280	3,320,699	333,965	3,654,664
1911 Ore or crude	34,412	1,278,239	142,718	4,866,207
1911 Unmanufactured, etc.	83,339	3,445,250		
1912 Ore or crude	45,280	1,781,585	169,119	4,503,682
1912 Unmanufactured, etc.	59,526	2,552,978		
1913 Ore or crude	48,942	1,863,406	90,694	5,040,210
1913 Unmanufactured, etc.	69,551	3,086,110		

WORLD'S PRODUCTION.

The world's output of crude platinum, 1910–1913, is given approximately in the following table:

World's production of crude platinum in 1910–1913, by countries, in troy ounces.

Country.	1910	1911	1912	1913
Russia	a 275,000	a 300,000	a 300,000	a 250,000
Canada	a 30	a 30	b 30	50
New South Wales and Tasmania c	332	470	a 778	1,500
Colombia	10,000	a 12,000	a 12,000	15,000
United States, domestic crude	390	628	721	483
United States, from foreign and domestic matte and bullion	d 1,000	d 1,200	d 1,300	d 1,100
Borneo and Sumatra and other e	a 209	.....	a 200	200
Total	286,961	314,328	315,029	268,333

a Estimated.
b In addition to platinum contained in matte and bullion refined in the United States.
c Chiefly iridosmine.
d Refined.
e Includes small production in Madagascar.

FOREIGN PRODUCTION.

RUSSIA.

The following description of the Russian platinum industry was furnished to the Mining Journal, London, by E. de Hautpick:[1]

The decision of the Imperial Government to impose a 30 per cent tax on imported platinum, which formed the subject of a recent contribution to the Mining Journal, is likely to have an important influence on the world's platinum market. The marked rise which has been witnessed in price since 1898 is due to the fact that whilst consumption of the metal has increased, fresh discoveries of ore have not kept pace. Consequently producers are compelled either to rewash their old tailings or undertake the exploitation of sands of lower or less remunerative content. There is a steady decline evident in the average yield from the Ural placers. The figure is now 0.05 ounce troy of crude platinum per ton of gravel. The corresponding contents for earlier periods were considerably higher—viz: 1894–1907, 0.09 ounce; 1883–1894, 0.1 ounce; 1850–1883, 0.33 ounce; 1838–1850, 0.4 ounce; 1829–1838, 0.5 ounce. Moreover, the cost of labor, timber, fuel, and taxes have all increased. The result is that the cost of production has largely appreciated. During the past three years the price has remained around £7 10s. ($36.50) per troy ounce for crude; previously there were rapid monthly fluctuations, varying as much as from 85s. ($20.68) to 175s. ($42.58), giving rise to great uncertainty in working.

With the steady prices of the last three years we can judge pretty well what is the normal production of the field. The output in 1913 amounted to 157,508 troy ounces, as against 177,375 ounces in 1912 and 185,381 ounces in 1911, thus showing a decline from 15,000 to 20,000 ounces per year. Looking at the industry over a longer period, the decade 1904 to 1913 gave a total production of 1,705,868 ounces, against 1,788,257 in 1894–1904, a diminution of 82,386 ounces, as compared with a decade previous. These figures show the substantial exhaustion of the placers.

The two principal centers of platinum production are Blagodat, on the Asiatic slope, and Nizhni-Tagilsk, on the European slope of the Ural Mountains. The Blagodat placers are in reality gold-platinum deposits. The Nizhni-Tagilsk placers contain platinum, and their production is twice as great as that of the Blagodat placers, and the quality of the ore [gravel] is also better, as can be seen by the following chemical analysis:

Analysis of Russian platinum gravels.

	Blagodat.	Nizhni-Tagilsk.
Platinum	81.50	88.75
Iridium	.90	.06
Osmium	.06	traces.
Ruthenium	-----	-----
Palladium	.05	1.30
Rhodium	2.90	4.44
Iron	7.35	10.82
Copper	.60	-----
Gold	-----	-----
Osmiridium	2.50	.11

The richest district is South Verkhotoor, which yielded during 1913, 102,408 ounces troy, 15,000 ounces less than in 1912. The North Verkhotoor district during 1913 produced 11,320 ounces of platinum—1,641 ounces less than in 1912. The Cherdensk district output in 1913 gave 6,155 ounces, or 50 ounces less. The Perm district production was 36,835 ounces, and the South Ekaterinburg 800 ounces.

A marked development in recent times has been the increase of dredging on the placers. * * * In 1913 about 22,000 ounces were won by dredges, and 137,000 ounces by hand labor. Since 1904 the dredge proportion has gone up from 4½ to 14 per cent. The extension of their use must depend to some extent on their being found suitable to work placers hitherto inaccessible to them. * * * The chief companies owning dredges at present are the Fedorovsky, the Platina, the Neviansk, the Draga, and the Nizhni-Tagilsk

[1] Min. Jour. (London), Mar. 14, 1914.

companies. The machinery of the last-named dredges was made in England at Arthur Brown's works, the pontoons [scows] themselves being constructed on the spot. The Neviansk Co.'s dredges were made by Werf-Conrad in Holland. Many of the dredges were, of course, constructed by the Putiloff works at St. Petersburg. Costly experience in the past has led to the companies exercising greater care in the selection of dredging ground. * * * But while platinum dredging has undoubtedly a great future in the Urals, neither in the Blagodat nor Nizhni-Tagilsk fields is it possible to expect the discovery of new placers, as in the 80 years that they have been worked they have been thoroughly investigated.

We can predict, therefore, that in 30 to 40 years' time these platiniferous districts of the Urals will be entirely exhausted. Hopes of fresh ground can only be entertained in the north of the Urals, where the olivine rocks are often met, and little prospecting has been done—as, for instance, on the River Ioutyn.

The exhaustion of the Russian platinum deposits may be delayed by the discovery of platinum in the Nikolaie-Pavadinsk district in the northern part of the Ural region, on the Crown estate of Vagransk, where the investigations of Prof. Dyupark have shown such splendid results as to cause considerable investment of capital on Nyasma River where dredges are being built. One of these is of the American type (Marion) and is driven by electricity. It would appear from reports that the reserves of platinum in the Urals are not so small as many believe.

By the end of 1913 the high price of platinum had taken labor from the gold fields of Russia to the platinum placers on account of better wages, and all available ground had been worked over. The tendency of the industry is to go into the hands of companies capable of operating on a large scale. As quoted by the Mining and Scientific Press there are among these companies the Ovsyankin Co., which is a purely Russian organiation controlling 109 placers in the Orenburg government. Counsellor Ratkoff-Rashnoff has formed a company with a capital of 10,000,000 rubles, known as the Lower Tagil Platinum & Mining Co., which will operate in the Perm government. Another company has been formed to work platinum deposits in the lower Tagil district belonging to the Demidoff successors and Prince San Donato. The passing of the control of the platinum fields into the hands of the larger operators is the natural sequence, in that the deposits have become of lower grade and it has become necessary to handle large quantities of material, requiring more expensive equipment and larger capital to work them. According to the Mining and Scientific Press, the method of working the deposits consists in dumping the sand into a stirrer and trommel, from which, after screening, it passes to the tables. The tailings from these ascend through a revolving cylinder containing a screw to a stacker.

The following description of the occurrence of platinum in the Ural Mountains is abridged from a contribution by E. de Hautpick.[1]

Occurrence of platinum in the Ural Mountains.—The search for platinum over the world has always been an interesting one to mining circles, and it has become still more engrossing as the period approaches for the introduction of the new Russian law to prevent the export of crude platinum. Therefore, it appears to me convenient to add to all my previous articles on this metal a geological description of the positions in which platinum is found in the Ural platinum placers, which have hitherto almost alone satisfied the requirements of industry.

[1] Min. Jour. (London), Sept. 20, 1913.

In the Urals there are two kinds of alluvia containing platinum—the alluvium of old river beds passing over the original rock, or the alluvium of more or less large rivers into which these old river beds lead. In the channels at the original sources of the platiniferous rivers, there are frequently thick beds of very ancient alluvium over the surface of which the present streams flow. Very frequently this alluvium is covered by eluvium. Platinum is usually found at the base of this alluvial bed, and the productive sands are of varying thicknesses, rarely exceeding 1.2 to 1.5 meters, and frequently not reaching the smaller limit. From this it does not follow that there is no platinum under these beds. It is found there in small—in fact, very small—quantities. The thickness of the barren ground varies; it frequently reaches to 10 meters, and even more, so that in many places the platiniferous beds are approached by underground workings. When we go past these old river beds, frequently it is not suspected that the whole lower stratum has been opened and worked out by drifts. Rarely only do we find here and there abandoned shafts by which the alluvium was brought to the surface. The position above referred to is not general. In many old river beds open workings are exploited, and the barren ground does not go deeper than 2 to 3 meters. In some cases the scarcely observed hollow of the river bed is taken up by eluvial products which have scarcely been subjected to scouring, rather than by alluvium. On the Nizhni-Tagil placers, for example, they are operating at a very small, almost unnoticeable depth; there would be scarcely water enough to wash the material produced, and they frequently work on not particularly steep inclines, on which the eluvial products, although not channeled, are distributed in known series of river systems. In river beds lying entirely in dunite the shingle of the alluvium has been formed exclusively of it, and of the vein rocks which traverse it. Among them we find large bowlders of chrome iron ore, and the sand remaining at the sluice box after washing consists entirely of chrome iron ore octahedrons. The alluvium of these river beds is sometimes fabulously rich in platinum, as for example, in Nizhni-Tagil and on the River Iss. The paltinum in these parts is usually large, slightly rounded and often still in inclosures of chrome iron ore. The very largest nuggets, as a rule, are found in these river beds. At present, in nearly all the original platinum deposits, the alluvium of these river beds has already been washed, and is now being washed a second, and even a third time. I have often heard that these sands under the action of the atmosphere become weathered, and that they consist in great part of dunite rock, and that the process discloses fresh platinum. This view is erroneous * * * Pieces of platiniferous clay which were not washed the first time, * * * being subjected to the action of the atmosphere, became a friable product which might contain platinum separable at a second washing. In the platiniferous rivers not far from the original deposits, alluvium is found arranged as follows: (1) In vegetive ground and peat beds of greater or less thickness. But the turf is absent in parts where the river bed is on a steep incline, and is almost always there where the river flows along a flat and wide valley, which in this case is usually, to a large extent, marshy. (2) Under the peat where there is barren gravel, separated from it by a thin layer of bluish clay. The thickness of this gravel varies for the different rivers between 0.8 and 2.5 meters. In exceptional circumstances it reaches 5 to 6 meters. The material referred to which constitutes it is formed of various rocks, which may differ greatly in different deposits. (3) Under gravel, the platiniferous alluvium being distinguished both in form and in color from the gravel that overlies it. The depth of the platiniferous alluvium varies between 0.8 and 2.5 meters, and seldom exceeds this limit. Under the platiniferous alluvium there lies a bed that may consist of various kinds of rock and is always friable. The platinum often sinks deep into it, so that it has to be extracted thence from a depth of 0.3 to 0.8 meters. When the bed consists of limestone, always more or less fissured, then the platinum falls into the chinks and accumulates there; it may go very deep—several meters below the bed of the river—and accumulate there, as in the present known pockets, which are sometimes spoken of as fabulously rich in this metal. The shingle of platiniferous alluvium varies, and, we will add, that not far from the original platiniferous center there is no sign of dunitic shingle in the alluvium. This rule may be proved over the whole of the Ural platinum deposits. It is the result of the very rapid destruction of this dunite, both during the period of the flow of water and as a consequence of the resulting decomposition. With serpentine it is different; thus in the River Visin, save for several hundred meters from the junction with the Rivers Rublevik and Zacharovka, there is no dunite in the alluvium, while the shingle

of the serpentine which accompanies the dunite in the original deposit is to be found in that very alluvium far down the river. The development of platiniferous alluvium all over the Urals is the same—post Tertiary. * * *

The distribution of the platinum in the alluvium is very irregular, and depends on the form of the river channel and the nature of the rock through which the river flows, on the existence of lateral platiniferous tributaries, etc. Wherever the solid rock forms a bar across the river, platinum gathers from the upper sources as in a natural riffle. Near the original center the platinum is large, slightly rounded, and often of a dark color. Small nuggets are not infrequently found. Further down, the platinum begins to become smaller, more and more rounded, and slightly white. At a great distance from the original center—as, for example, on the River Tura—the platinum is changed into sandy grains of uniform size, formed by contact with stones. Generally the content of platinum in the alluvium, which is fairly regular, decreases from the upper reaches to the mouth of the river, with the exception of cases where there are platiniferous tributaries. Besides this, in every given section the very richest part is seldom found in an existing river channel, as the axis of the old bed along which the richest content is distributed is often deflected to the right or to the left, and is often found at a considerable distance from the existing channel. Sometimes in the alluvium of the tribuatries of the large platiniferous rivers we find platinum in large quantities, while these tributaries from the source to the mouth flow through barren ground, for example, in limestone or crystalline schist. In this occurrence we shall find nothing abnormal if we remember that at the beginning the alluvial covering of some rivers was very extensive. The lateral tributaries, which were fresher in development, once more broke open this covering, and scoured it in places, so that the platinum contained in it underwent a second concentration. This particularly applies to some tributaries of the Lower Iss—for example, the Shuravlika.

* * * Sometimes certain rivers formed a kind of alluvial cover, which corresponded to the succeeding change of their channel. In this category we find the River Martian, as in its upper reaches there is the old channel to the east of the present one at the foot of the White Mountain, and on the upper level the alluvium is hidden under a deep bed of material carried down, and of eluvium. It is the same in the River Iss. On looking at the chart of the platinum placers on this river, we are at once struck with the unusual width of the alluvial plateau of the river, and see that there exist at least two distinct directions in which the deposits of alluvium took form. The presence of this platiniferous alluvium in places where all the rock is not productive explains the existence of platinum in some of the large rivers, which ought not to be platiniferous, as, for example, the Aktai. * * *

Production of platinum in Russia, in fine ounces, from 1900 to 1913.

Year.	Official.	Estimated total.	Year.	Official.	Estimated total.
1900	163,060	212,500	1907	172,752	310,000
1901	203,057	315,200	1908	156,792	250,000
1902	197,024	300,000	1909	164,118	264,000
1903	192,976	226,000	1910	175,716	275,000
1904	161,950	290,120	1911	180,400	300,000
1905	167,950	200,450	1912	177,375	300,000
1906	185,792	210,318	1913	129,384	250,000

COLOMBIA.

As the production of platinum in Russia will probably decline in the next few years, the attention of the platinum trade is directed more and more toward Colombia as a favorable source of the future supply. This country has already far outstripped all other regions except Russia, and yet most of the metal obtained is only the irregular production of the natives, using crude methods for its extraction. The main region in Colombia for platinum is the Choco, including the tributary rivers. This is the only region in the world, aside from Russia, where platinum is obtained in much greater pro-

portion than gold. At present the natives, both men and women, extract a considerable proportion of the platinum by panning down the gravel below the surface to as great an extent as possible and finishing it on returning to the surface. The platinum is then bartered to the traders for clothes and ornaments, and sometimes for money.

Many efforts which have been made to institute large modern dredging appliances have been baffled by two obstacles—the great freshets on the river and the extremely insanitary conditions of the region. Fevers prevail to an extent which is almost prohibitory for the work of any but natives, yet it is probable that the occurrence of platinum in this region is so great as to justify the sanitary measures taken in the development of the Panama Canal for protection of the foreign workmen.

E. B. Kimball,[1] in describing the primitive methods of working the platinum areas on Atrato River and its tributaries to the south of the old trading center at Quibdo, states that the gravel contains 90 parts gold to 10 parts platinum. He attributes the gold and platinum to erosion of veins along the flanks of the Andes Mountains. Besides gold-bearing quartz, he was shown a specimen of a basic igneous rock, probably peridotite, carrying native platinum in small, flaky particles.

In the Daily Consular and Trade Reports of 1914, No. 62, Louis G. Dreyfus, jr., United States consular agent at Quibdo, Colombia, describes the development of the Choco intendency and gives, in addition to much general information, the following concerning gold and platinum mining:

> The gold-mining district extends from the junction of the Negua and Atrato rivers south to the mouth of the San Juan. Almost all the deposits are alluvial. There is at work in the field only one large company, formed with British capital, which is extensively sampling with drills and tunnels on Condoto River, an affluent of the San Juan.
>
> Most of the gold and platinum exported is obtained by native women, working two or three hours per day. They use the antiquated ground-sluicing process * * * to get rid of the coarser gravels, and then with their "bateas" separate the metals from the sand and gravel. The batea is a wooden pan, shaped like a very shallow inverted cone, 18 inches in diameter and 3 inches deep at the center, with two small handles or knobs on the rim. The women handle the bateas with great dexterity, throwing off the gravel and sand by a rotary motion and leaving the gold and platinum dust in the center. Another method of mining that is extensively employed by these women is diving into 3 or 4 feet of water for the sand and gravel containing the metals and bringing it up in the bateas. This method is usually more remunerative than the sluicing process.
>
> The gold workings have existed for centuries, but little has been done in the development of the district. The river gravels were being washed by the Indians long before the advent of the Spaniards, and this region furnished much of the gold that was carried back to Spain. In those days the value of platinum was unknown, and when the Indians brought the metal down to the Spanish headquarters in Quibdo the platinum was thrown away. Large finds of this discarded metal have been made recently in Quibdo, and frequently the earth excavated for foundations has yielded sufficient quantities of platinum to pay for putting up the building. The natives were beginning to pan even the street, thus uncovering large amounts of mud, which was injurious to health. A decree was therefore promulgated in 1913 prohibiting any further washing of earth in the streets of Quibdo.

Consular Agent Dreyfus estimates exports of platinum at 542.4 pounds, or 6,509 ounces. In explanation of the fact that this is much less than the figures usually quoted as the yield of platinum in

[1] Kimball, E. B., Min. and Met. Soc. America Bull. 65, October, 1913.

Colombia, he states that without doubt a larger quantity of platinum was exported via Buenaventura, the outlet of the Province of San Juan.

GERMANY.

About the close of the year 1913 a report was widely circulated that platinum had been discovered in Meuden, Westphalia, in the region previously well known for its deposits of other metals. It was stated that over a territory of 500 acres borings had shown the presence of from 1 to 2 ounces of platinum to the cubic yard. The investigations of some of the platinum refineries, including analyses by them, are reported as failing to show profitable quantities of platinum, and further verifications of the rumor have not been received.

USES.

So long as the price of platinum remains at the present high mark it is not probable that its uses will be much extended. It is a question of maintaining the sale of all the platinum for the uses to which it is now put rather than of seeking to apply platinum to other uses covered at the present by other materials.

The decreased use of platinum for electric-light bulbs has been practically compensated by the increased use of platinum for jewelry. This has developed into a definite and apparently permanent form of ornament, and the sales of platinum for that purpose are steadily increasing.

The use of platinum sponge and of platinum black as a catalyzer is extending steadily with the increased manufacture of sulphuric acid, and there is prospect of the use of this material, in spite of its price, for many other applications of chemical action involving catalysis. The platinum sponge is more frequently used thoroughly mixed with asbestos fiber, in order to spread the platinum over greater surface. The relative permanency of platinum, as compared with nickel and other metals, is greatly in favor of this more expensive metal.

Great activity has been shown in chemical research in regard to the properties of the metals of the platinum group, especially by Sir William Crookes,[1] in regard to the volatility of platinum and other metals of the platinum group when used in resistance furnaces, and interesting studies have also been made in the photoelectric properties of thin films of platinum.

In the use of platinum, improvements have been recorded by F. A. Gooch and W. L. Burdick,[2] in regard to using films of platinum deposited on glass in the place of costly massive platinum in electrolytic analysis. The action of platinum metals as catalyzers has been advanced by the work of many chemists, particularly in the hydrogenation of various substances.

ALLIED METALS.

Iridium.—The price of iridium remains much higher than that of platinum, because of its relative scarcity and its usefulness in hardening platinum, as described in previous reports. It is necessary for

[1] Royal Soc. London Proc., vol. 86A, pp. 461–477.
[2] Am. Jour. Sci., 4th ser., vol. 34, pp. 107–112, 1912.

statistical purposes, however, to point out the mistake of the usual platinum miner in speaking of iridosmine as "iridium." It should be borne in mind that iridosmine is an alloy of osmium and iridium, with percentages of osmium varying from 17 to 49, as described by J. F. Kemp.[1] There is practically no market for osmium, except the use as pen points; therefore iridosmine is only valuable for the iridium contained. The extraction of osmium is very costly, and also dangerous on account of the poisonous character of the osmium vapor.

Palladium.—The supply of palladium available for trade increased slightly on account of the greater care taken in treating the slimes of copper refineries. The palladium is found with gold, silver, etc., and in the slime of Canadian matte, and also from the base bullion from Australia and elsewhere. The use of palladium as a catalyzer is well known, and it is much in favor for this use. Its consumption has also increased as an alloy for platinum for ornamental purposes, as it renders the platinum lighter and of a more brilliant white.

Osmium.—The supply of this member of the platinum group is in excess of the present demand, because tungsten has replaced it for filaments in incandescent lighting, and its use in medicine and in silk dyeing is extremely slight.

[1] U. S. Geol. Survey Bull. 193, p. 26, 1902.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN CALIFORNIA AND OREGON IN 1913.

(MINES REPORT.)

CALIFORNIA.

By Charles G. Yale.

PRODUCTION.

Number of mines producing in California, quantity of ore sold or treated in 1905–1913, and total gold, silver, copper, lead, and zinc.

Year.	Number of mines producing.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	1,139	2,696,603	$18,898,545	1,076,174	16,697,544	447,723	.....	$22,174,413
1906	1,017	2,556,056	18,732,452	1,220,641	28,726,448	338,718	206,000	25,126,359
1907	1,061	2,054,653	16,727,928	1,138,858	28,528,020	2,625,419	233,550	23,338,104
1908	1,054	2,546,908	18,761,559	1,647,278	38,776,881	1,237,548	.....	24,805,141
1909	1,127	3,041,688	20,237,870	2,098,253	57,288,281	1,502,597	.....	28,841,050
1910	1,079	2,697,885	19,715,440	1,840,085	48,700,756	2,870,977	.....	27,020,405
1911	1,181	2,797,261	19,738,908	1,270,445	36,316,136	1,398,111	2,807,035	25,174,677
1912	1,041	2,641,497	19,713,478	1,300,136	33,451,672	1,144,731	4,345,591	26,383,946
1913	796	2,495,958	20,406,958	1,378,399	34,575,007	3,514,342	1,057,485	26,812,487
Increase (+) or decrease (−)	−245	−145,539	+693,480	+78,263	+1,123,335	+2,369,611	−3,288,106	+428,541

This tabular statement of the production of metals in California in 1913 shows that there was a decrease in the number of productive mines, in total tonnage of ore treated, and in the output of zinc, but that the increase in the value of the gold, silver, copper, and lead made the total value of the output $428,541 more than in 1912. The value of the gold production increased $693,480; the silver output increased by 78,263 ounces and the copper by 1,123,335 pounds. The decline in the zinc production was material, but the output of lead more than doubled in quantity. The value of gold in the lead ores materially decreased in 1913, as compared with 1912.

In connection with this table also and uniform tables following in this chapter where separate counties are considered, it must be borne in mind that the gold values and the silver quantities bear no relation to the figures of tonnage, although the other substances do. The reason is that not only the deep-mine gold and silver, but also placer-mine gold and silver are combined under the respective headings of these metals in the general tables. Other tables are provided, however, to show the details. For example, in the table above, the

total gold output for 1913 is shown as $20,406,958, of which $11,570,781 was derived from deep mines and $8,836,177 from placers of various kinds. In the same way, of the total silver output of 1,378,399 fine ounces, 1,343,020 fine ounces were from deep mines and 35,379 from the placers. Under head of producing mines, both deep and placer mines are enumerated.

In 1913 there were 796 properties reporting production, of which 410 were deep mines and 386 were placers. There were 245 less producing mines in 1913 than in 1912. The producing deep mines of 1913 may be classified by metal product as follows: Gold, 317; copper, 51; silver, 6; silver-lead and lead, 34; zinc, 2. Of the placer mines, 108 were hydraulic, 63 dredges, 85 drift, and 130 surface. There were 123 fewer placers operating in 1913 than in 1912. In 1913 there was a decrease of 153 gold mines, an increase of 27 copper mines, a decrease of 6 silver mines, an increase of 9 silver-lead and lead mines, and an increase of 1 zinc mine—a net decrease of 122 deep mines. The dredges are enumerated by the number of boats at work, some companies owning several and some only one. There were 33 fewer hydraulic mines productive in 1913 than in 1912, 27 less surface placers, 2 less dredges, and 61 less drift mines.

The 410 deep mines producing in the State in 1913 made an output of 2,495,958 tons of ore, 145,539 less than in 1912. Of this output, 2,031,429 tons were siliceous ore, 448,439 tons copper ore, 14,267 tons lead ore, and 1,823 tons zinc ore. The siliceous ore decreased by 194,000 tons, the copper ore increased by 39,817 tons, the lead ore increased by 13,293 tons, and the zinc ore decreased by 4,649 tons.

The siliceous ore yielded an average per ton in gold and silver of $5.61; the copper ore, $1.84; and the lead ore, $11.24. The zinc ore produced neither gold nor silver. The average in gold and silver value from all ores treated in the State in 1913 was $4.96 per ton.

The 2,495,958 tons of ore of all classes treated in California in 1913 yielded 559,736.53 fine ounces of gold, valued at $11,570,781; 1,343,020 fine ounces of silver, valued at $811,184; 34,575,007 pounds of copper, valued at $5,359,126; 3,514,342 pounds of lead, valued at $154,631; and 1,057,485 pounds of zinc, valued at $59,219.

The value of all metals obtained from ore mined and treated in California in 1913 was $17,954,941, an average of $7.19 per ton. In 1912 the output was valued at $17,716,357, from 2,641,497 tons of ore of all classes, an average value of $6.71 per ton; in 1911 the output was 2,797,261 tons, valued at $16,167,193, an average value per ton of $5.49; in 1910 the output was 2,697,885 tons, valued at $18,109,008, an average value of $6.71 per ton; in 1909 it was 3,041,688 tons, valued at $19,715,314, an average of $6.48 per ton; and in 1908 it was 2,546,908 tons, valued at $16,536,226, an average value per ton of $6.49.

In 1913 there were treated at gold and silver mills 1,905,258 tons of ore, containing altogether $10,532,901 in gold, an average value of $5.52 per ton, and 164,048 fine ounces of silver, valued at $99,087, an average value of 5 cents per ton. This gives a total value of $10,631,988 in gold and silver thus treated, an average value per ton of $5.57 in both metals. The average value in 1912 was $5.08 per ton; in 1911 it was $4.64; in 1910 it was $5.25; in 1909 it was $4.88; in 1908 it was $5.08.

There was recovered as bullion in the mills $8,469,245 in gold, averaging $4.44 per ton, and 126,003 ounces of silver, valued at $76,105, averaging 4 cents per ton, a total of $8,545,350 in gold and silver, averaging $4.48 per ton in both metals.

From 1,905,258 tons of gold milling ore, 32,652 tons of concentrates were obtained, valued at $2,063,656 in gold, an average of $63.20 per ton, and 38,046 ounces of silver, valued at $22,980, an average of 70 cents per ton. This was a yield in gold and silver valued at $2,086,636, or an average value recovered from the concentrates of $63.90 per ton in gold and silver.

Of the smelting ores there were 531,189 tons produced, with an output of $840,030 in gold, an average of $1.58 per ton, and of 1,158,517 fine ounces of silver, valued at $699,745, an average recovery of $1.32 per ton. The total yield of gold and silver in the smelting ores was $1,539,775, or an average of $2.90 per ton.

There were treated also 59,511 tons of old tailings, producing $197,850 in gold, an average of $3.32 per ton, and 20,454 fine ounces of silver, valued at $12,354, an average of 21 cents per ton. The total gold and silver produced from the tailings was valued at $210,204, an average of $3.53 per ton.

The 386 productive placer mines in California in 1913 yielded 427,450.06 fine ounces of gold, valued at $8,836,177, and 35,379 fine ounces of silver, valued at $21,369, a total value in gold and silver of $8,857,546. This was an increase of $189,957 over the output of 1912. The gold increase was $190,514, but the value of the silver output decreased by $557. In gold production the dredge properties showed an increase of $660,339 in 1913, and the hydraulic mines a decrease of $360,382. In the same period the drift mines showed a decrease of $195,454 and the surface placer or sluicing mines an increase of $86,011.

The following table shows the production of gold, silver, copper, lead, and zinc in California in 1913, by counties:

Production of precious metals, by source and counties, and production of copper, lead, and zinc, by counties, in California in 1913.

County.	Ore treated.	Deep-mine gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ozs.*		*Fine ozs.*		*Fine ozs.*	
Alpine	9	25.98	$537			25.98	$537
Amador	640,593	138,780.52	2,868,848	1,598.79	$33,050	140,379.31	2,901,898
Butte	13,559	1,744.69	36,066	108,059.25	2,233,783	109,803.94	2,269,849
Calaveras	414,006	35,583.39	735,574	21,267.29	439,634	56,850.68	1,175,208
Del Norte				120.84	2,498	120.84	2,498
Eldorado	16,798	2,041.23	42,196	991.30	20,492	3,032.53	62,688
Fresno	485	137.68	2,846			137.68	2,846
Humboldt	23			1,238.93	25,611	1,238.93	25,611
Imperial	10,479	1,533.49	31,700			1,533.49	31,700
Inyo	38,064	11,479.87	237,310			11,479.87	237,310
Kern	147,131	31,317.15	647,383	112.67	2,329	31,429.82	649,712
Lassen	21						
Los Angeles	185	112.33	2,322			112.33	2,322
Madera	3,545	686.39	14,189	14.51	300	700.90	14,489
Mariposa	20,671	8,103.54	167,515	170.23	3,519	8,273.77	171,034
Merced	111	109.09	2,255	(a)	(a)	109.09	2,255
Modoc	441	293.20	6,061			293.20	6,061
Mono	21,953	6,858.22	141,772	266.02	5,499	7,124.24	147,271
Monterey	179	314.00	6,491			314.00	6,491
Nevada	276,306	140,329.01	2,900,858	864.70	17,875	141,193.71	2,918,733

[a] Dredge production combined to conceal output of single dredge.

Production of precious metals, by source and counties, and production of copper, lead, and zinc, by counties, in California in 1913—Continued.

County.	Ore treated.	Deep-mine gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ozs.*		*Fine ozs.*		*Fine ozs.*	
Placer	17,683	4,052.42	$83,771	6,628.05	$37,014	10,680.47	$220,785
Plumas	35,354	3,956.74	81,793	2,736.82	56,575	6,693.56	138,368
Riverside	780	604.74	12,501			604.74	12,501
Sacramento				121,113.25	2,503,633	121,113.25	2,503,633
San Bernardino	40,513	17,207.66	355,714	39.19	810	17,246.85	356,524
San Luis Obispo				6.00	124	6.00	124
Shasta	477,746	55,373.70	1,144,676	3,105.38	64,194	58,479.08	1,208,870
Sierra	74,656	45,033.50	930,925	3,659.47	75,648	48,692.97	1,006,573
Siskiyou	3,508	2,392.53	49,458	[a] 6,321.01	130,667	8,713.54	180,125
Stanislaus				[a] 9.68	200	[a] 9.68	200
Trinity	3,497	3,548.79	73,300	17,342.53	358,502	20,891.33	431,862
Tuolumne	236,062	46,572.69	962,743	564.34	11,666	47,137.03	974,409
Yuba	1,600	1,543.98	31,917	118,982.57	2,459,588	120,526.55	2,491,505
Merced, Siskiyou, and Stanislaus[a]				12,237.23	252,966	12,237.23	252,966
Total	2,495,958	559,736.53	11,570,781	427,450.06	8,836,177	987,186.59	20,406,958
Total, 1912	2,641,497	535,405.55	11,067,815	418,233.95	8,645,663	953,639.50	19,713,478
Increase (+) or decrease (−)	−145,539	+24,330.98	+502,966	+9,216.11	+190,514	+33,547.09	+693,480

County.	Deep-mine silver.		Placer silver.		Total silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Fine ozs.*		*Pounds.*	
Alpine	6	$4			6	$4		
Amador	29,626	17,894	336	$203	29,962	18,097	19,015	$2,947
Butte	316	191	8,232	4,972	8,548	5,163	30	5
Calaveras	99,257	59,951	1,863	1,125	101,120	61,076	5,823,226	902,600
Del Norte			27	16	27	16		
Eldorado	272	164	142	86	414	250	703	109
Fresno	25	15			25	15		
Humboldt	18	11	200	121	218	132	7,852	1,217
Imperial	156	94			156	94		
Inyo	226,579	136,854			226,579	136,854	114,213	17,703
Kern	19,604	11,841	17	10	19,621	11,851	3,432	532
Lassen	3	2			3	2	2,258	350
Los Angeles	45	27			45	27		
Madera	2,674	1,615	3	2	2,677	1,617	531,819	82,432
Mariposa	12,268	7,410	33	20	12,301	7,430	439,168	68,071
Merced	152	92	(a)		152	92	1,568	243
Modoc	156	94			156	94		
Mono	38,449	23,223	66	40	38,515	23,263	79,323	12,295
Monterey	45	27			45	27		
Nevada	43,828	26,472	116	70	43,944	26,542		
Placer	4,348	2,626	573	346	4,921	2,972	374	58
Plumas	904	546	263	159	1,167	705	22,677	3,515
Riverside	172	104			172	104		
Sacramento			5,639	3,406	5,639	3,406		
San Bernardino	73,526	44,410	5	3	73,531	44,413	484,568	75,108
San Luis Obispo			2	1	2	1		
Shasta	741,028	447,581	[a] 745	450	741,773	448,031	27,044,297	4,191,866
Sierra	6,738	4,070	389	235	7,127	4,305	484	75
Siskiyou	954	576	1,080	652	2,034	1,228		
Stanislaus			[a] 1	1	1	1		
Trinity	1,435	867	2,073	1,252	3,508	2,119		
Tuolumne	40,290	24,335	76	46	40,366	24,381		
Yuba	146	88	12,389	7,483	12,535	7,571		
Merced, Siskiyou, and Stanislaus[a]			1,109	670	1,109	670		
Total	1,343,020	811,184	35,379	21,369	1,378,399	832,553	34,575,007	5,359,126
Total, 1912	1,264,484	777,658	35,652	21,926	1,300,136	799,584	33,451,672	5,519,526
Increase (+) or decrease (−)	+78,536	+33,526	−273	−557	+78,263	+32,969	+1,123,335	−160,400

[a] Dredge production combined to conceal output of single dredge.

Production of precious metals, by source and counties, and production of copper, lead, and zinc, by counties, in California in 1913—Continued.

County.	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Alpine					$541
Amador					2,922,942
Butte	362	$16			2,275,033
Calaveras					2,138,884
Del Norte					2,514
El Dorado					63,047
Fresno					2,861
Humboldt					26,960
Imperial					31,794
Inyo	3,246,432	142,843	963,571	$53,960	588,670
Kern	159	7			662,102
Lassen					352
Los Angeles					2,349
Madera					98,538
Mariposa					246,535
Merced					2,590
Modoc					6,155
Mono					182,829
Monterey					6,518
Nevada					2,945,275
Placer	682	30			223,845
Plumas	5,432	239			142,827
Riverside					12,605
Sacramento					2,507,039
San Bernardino	237,480	10,449			486,494
San Luis Obispo					125
Shasta	19,295	849	93,914	5,259	5,854,875
Sierra	4,159	183			1,011,136
Siskiyou					181,353
Stanislaus					201
Trinity	341	15			433,996
Tuolumne					998,790
Yuba					2,499,076
Merced, Siskiyou, and Stanislaus [a]					253,636
Total	3,514,342	154,631	1,057,485	59,219	26,812,487
Total, 1912	1,144,731	51,512	4,345,591	299,846	26,383,946
Increase (+) or decrease (−)	+2,369,611	+103,119	−3,288,106	− 240,627	+ 428,541

[a] Dredge production combined to conceal output of single dredge.

GOLD.

The total gold production in California in 1913 was 987,186.59 fine ounces, valued at $20,406,958, as compared with 953,639.50 fine ounces, valued at $19,713,478, in 1912, an increase of 33,547.09 fine ounces, valued at $693,480, or 3.52 per cent for 1913. The deep mines of the State yielded 559,736.53 fine ounces of gold, valued at $11,570,781. Of the deep-mine gold, 542,891.65 fine ounces, valued at $11,222,566, was derived from siliceous ore; 15,525.41 fine ounces, valued at $320,939, was derived from copper ore; and 1,319.47 fine ounces, valued at $27,276, from lead ore.

The total placer yield of gold in 1913 was 427,450.06 fine ounces, valued at $8,836,177. Of this, $329,300 was derived from 108 hydraulic mines, $8,090,294 was from 63 dredges, $192,538 from 85 drift mines, and $224,045 from 130 surface or sluicing mines. The deep mines of California produced $2,734,604 more gold than the combined placers of the State in 1913. The placers produced 43.30 per cent of the total gold yield for 1913, and the deep mines 56.70 per cent, as compared with 43.86 per cent for the placers and 56.14 for the deep mines in 1912.

The dredges in the State produced 39.64 per cent of the total gold yield from all sources in 1913. Of total placer gold the dredges produced 91.56 per cent; the hydraulic mines, 3.73 per cent; the drift mines, 2.18; and the surface or sluicing mines, 2.53 per cent. The dredge-mining record for the last 15 years is shown in the table following, with the increase or decrease for each year:

Value of gold won by dredging in California, 1899–1912, with increase (+) or decrease (−) by years.

Year.	Value.	Increase (+) or decrease (−).	Year.	Value.	Increase (+) or decrease (−)
1899	$206,302		1908	$6,536,189	+$1,470,752
1900	200,929	− $5,373	1909	7,382,950	+ 846,761
1901	471,762	+ 270,833	1910	7,550,254	+ 167,304
1902	867,665	+ 395,903	1911	7,666,461	+ 116,207
1903	1,475,749	+ 608,084	1912	7,429,955	− 236,506
1904	2,187,038	+ 711,289	1913	8,090,294	+ 660,339
1905	3,276,141	+ 1,089,103			
1906	5,098,359	+ 1,822,218	Total	63,505,485	
1907	5,065,437	− 32,822			

The three great dredging fields of the State are at Oroville, Butte County; Folsom, Sacramento County; and near Marysville, Yuba County. Dredges are also operated in five other counties, but mainly in isolated localities with only one or two dredges at work in each. The only exception to this is at Jenny Lind, Calaveras County, where there were four dredges at work during 1913. In these districts outside of the main and more important fields, the dredges are not usually of large digging capacity. The Yuba County field decreased its annual output of gold by $295,742. In Butte County the Oroville field decreased in yield of dredge gold by $162,179 in 1913, but owing to the increase in gold production from dredges in other parts of the county, the decrease in the total yield of dredge gold of the county, as a whole, amounted to only $149,070. Sacramento County increased its dredging output by $825,806, which more than made up the loss in dredge gold in Yuba and Butte counties. In Yuba County 12 dredges operated during 1913, as compared with 14 in 1912, and 13 in 1911; in Butte County there were 25 dredges, as compared with 28 in 1912, and 30 in 1911; and in Sacramento County there were 12 dredges, as compared with 11 in 1912, and 10 in 1911. There were 4 in Calaveras County, 3 in Placer County, 2 in Trinity, and 2 in Shasta. In Merced, Siskiyou, and Stanislaus counties there was 1 dredge each at work. The details of such changes as have occurred will be described under the headings of the respective counties where dredging was carried on in 1913.

Of the 32 counties producing gold in California in 1913, 9 yielded no placer gold and 5 yielded no gold from deep mines. Eight counties yielded over $1,000,000 each in gold in 1913, as follows: Nevada, $2,918,733; Amador, $2,901,898; Sacramento, $2,503,633; Yuba, $2,491,505; Butte, $2,269,849; Shasta, $1,208,870; Calaveras, $1,175,208; and Sierra, $1,006,573. There were only 4 counties in 1912 which yielded over $2,000,000, but in 1913 there were 5, the new one being Sacramento County, which stood second in rank in the matter of increased gold yield for the year.

The largest production of gold in California in 1913 came, as shown, from Nevada County, which took precedence over Amador, which ranked first in 1912. The leading hydraulic mining county was Siskiyou; the greatest producer of gold from drift mines was Placer; the largest producer of gold from dredges was Sacramento; and the largest producer of gold from surface or sluicing mines was Butte. The largest increase in total gold yield in 1913 was in Nevada County, an increase of $836,775, which was followed by Sacramento, with $791,046; Shasta, with $222,067; Calaveras, with $213,063; Amador, with $105,704; San Bernardino, with $62,624; and Mariposa, with $10,493. Some counties showed a decreased yield of gold for the year, as Trinity, $291,641; Siskiyou, $240,342; Mono, $230,247; Kern, $180,708; Placer, $146,598; Tuolumne, $138,882; Inyo, $132,418; Butte, $76,380; Plumas, $54,869; and El Dorado, $42,877.

The production of gold from placers and from different kinds of ore in California in 1913 by counties, in fine ounces, is given in the following table:

Source of gold production in California by kinds of ore in 1913, by counties, in fine ounces.

County.	Placers.	Deep mines.					Grand total.
		Siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Total.	
Alpine		25.98				25.98	25.98
Amador	1,598.79	138,742.89	37.63			138,780.52	140,379.31
Butte	108,059.25	1,738.69		6.00		1,744.69	109,803.94
Calaveras	21,267.29	32,946.57	2,636.82			35,583.39	56,850.68
Del Norte	120.84						120.84
El Dorado	991.30	2,041.23				2,041.23	3,032.53
Fresno		137.68				137.68	137.68
Humboldt	1,238.93						1,238.93
Imperial		1,533.49				1,533.49	1,533.49
Inyo		10,311.47	62.21	1,106.19		11,479.87	11,479.87
Kern	112.67	31,316.72	.43			31,317.15	31,429.82
Lassen							
Los Angeles		112.33				112.33	112.33
Madera	14.51	677.15	9.24			686.39	700.90
Mariposa	170.23	7,784.70	318.84			8,103.54	8,273.77
Merced		108.99	.10			109.09	109.09
Modoc		293.20				293.20	293.20
Mono	266.02	6,856.24	1.98			6,858.22	7,124.24
Monterey		314.00				314.00	314.00
Nevada	864.70	140,329.01				140,329.01	141,193.71
Placer	6,628.05	4,049.42	3.00			4,052.42	10,680,47
Plumas	2,736.82	3,920.31	36.43			3,956.74	6,693.56
Riverside		604.74				604.74	604.74
Sacramento	121,113.25						121,113.25
San Bernardino	39.19	16,855.11	147.25	205.30		17,207.66	17,246.85
San Luis Obispo	6.00						6.00
Shasta	3,105.38	43,100.24	12,271.48	1.98		55,373.70	58,479.08
Sierra	3,659.47	45,033.50				45,033.50	48,692.97
Siskiyou	6,321.01	2,392.53				2,392.53	8,713.54
Stanislaus	9.68						9.68
Trinity	17,342.54	3,548.79				3,548.79	20,891.33
Tuolumne	564.34	46,572.69				46,572.69	47,137.03
Yuba	118,982.57	1,543.98				1,543.98	120,526.55
Merced, Siskiyou, and Stanislaus[a]	12,237.23						12,237.23
Total	427,450.06	542,891.65	15,525.41	1,319.47		559,736.53	987,186.59
Total, 1912	418,233.95	521,083.83	14,219.65	83.06	19.01	535,405.55	953,639.50
Increase (+) or decrease (−)	+9,216.11	+21,807.82	+1,305.76	+1,236.41	−19.01	+24,330.98	+33,547.09

[a] Dredge production combined to conceal output of single dredge.

From the siliceous ore and from old tailings the recovery of gold by processes in California in 1913 was as follows: By amalgamation,

360,101.85 fine ounces, valued at $7,443,966; by cyanidation, 62,372.45 fine ounces, valued at $1,289,353; and by chlorination, 4,208.53 fine ounces, valued at $86,998. There was but one chlorination plant in operation in the State in 1913. There were 35 separate plants where the cyanide process was used in 1913. Gold valued at $840,030 was obtained from smelting ores, and $1,910,434 in gold was obtained from concentrates treated at custom reduction plants and smelters.

The source of placer gold, by counties, and from various kinds of mines, is shown as follows:

Source of placer gold in California in 1913, by counties.

County.	Hydraulic.	Dredging.	Drift.	Surface placers.	Total.
Amador			$11,449	$21,601	$33,050
Butte	$4,871	$2,122,926	43,894	62,092	2,233,783
Calaveras	2,480	417,423	2,969	16,762	439,634
Del Norte	1,107		1,000	391	2,498
El Dorado	2,851		12,866	4,775	20,492
Humboldt	25,239			372	25,611
Kern				2,329	2,329
Madera				300	300
Mariposa				3,519	3,519
Merced, Siskiyou, and Stanislaus [a]		252,966			252,966
Mono				5,499	5,499
Nevada			7,696	10,179	17,875
Placer		78,839	44,826	13,349	137,014
Plumas	16,775		31,139	8,661	56,575
Sacramento		2,498,603		5,030	2,503,633
San Bernardino				810	810
San Luis Obispo				124	124
Shasta		58,193	900	5,101	64,194
Sierra	47,471		21,644	6,533	75,648
Siskiyou	124,345		330	5,992	130,667
Stanislaus				200	200
Trinity	104,161	240,889	1,500	11,952	358,502
Tuolumne			9,166	2,500	11,666
Yuba		2,420,455	3,159	35,974	2,459,588
Total	329,300	8,090,294	192,538	224,045	8,836,177

[a] Yield of single dredge in each county combined to conceal separate output.

The increase or decrease of gold production, by counties, in 1913 as compared with 1912, is shown in the following table:

Increase and decrease in gold production in California in 1913, by counties.

County.	Increase.	Decrease.	County.	Increase.	Decrease.
Alpine		$1,227	Nevada	$836,775	
Amador	$105,704		Placer		$146,598
Butte		76,380	Plumas		54,869
Calaveras	213,063		Riverside		7,701
Del Norte		1,442	Sacramento	791,046	
El Dorado		42,877	San Bernardino	62,624	
Fresno		3,248	San Luis Obispo		852
Humboldt		5,660	Shasta	222,067	
Imperial	31,700		Sierra	273,585	
Inyo		132,448	Siskiyou		240,342
Kern		180,708	Stanislaus	200	
Los Angeles		914	Trinity		291,641
Madera	5,327		Tuolumne		138,882
Mariposa	10,493		Yuba		261,903
Merced		22,389			
Modoc		21,832	Total	2,555,640	1,862,160
Mono		230,247	Total increase	693,480	
Monterey	3,056				

SILVER.

The yield of silver in California in 1913 was 1,378,399 fine ounces, valued at $832,553, an increase in quantity of 78,263 fine ounces, or 6.02 per cent, and of $32,969 in value, or 4.12 per cent. The larger portion of the output, or 1,158,517 fine ounces, valued at $699,745, was derived from crude smelting ores. The output of siliceous ore, both milled and smelted, yielded 289,119 fine ounces, valued at $174,628. The largest production of silver was, as usual, from Shasta County, which yielded from the smelting of copper ores 705,634 fine ounces, valued at $426,203; from siliceous ore, 35,295 fine ounces; from placers, 745 fine ounces; and from lead ore, 99 fine ounces—a total yield from the county of 741,773 fine ounces, valued at $448,031. In 1912 Shasta County produced 691,678 fine ounces of silver, valued at $425,382, the increase for 1913 in quantity being 50,095 fine ounces, and the increase in value $22,649. The silver obtained with gold in placer mining in the State in 1913 was 35,379 fine ounces, valued at $21,369. The largest producer of placer silver was Yuba County, with 12,389 fine ounces, valued at $7,483.

The following table shows the source of silver output in California in 1913, by placers and kinds of ore, in fine ounces:

Source of silver production in California by kinds of ore in 1913, in fine ounces.

County.	Placers.	Deep mines.					Grand total.
		Siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Total.	
Alpine		6				6	6
Amador	336	28,528	1,098			29,626	29,962
Butte	8,232	149		167		316	8,548
Calaveras	1,863	12,802	86,455			99,257	101,120
Del Norte	27						27
El Dorado	142	250	22			272	414
Fresno		25				25	25
Humboldt	200		18			18	218
Imperial		156				156	156
Inyo		6,814	6,381	213,384		226,579	226,579
Kern	17	18,723	881			19,604	19,621
Lassen			3			3	3
Los Angeles		45				45	45
Madera	3	113	2,561			2,674	2,677
Mariposa	33	2,266	10,002			12,268	12,301
Merced		36	116			152	152
Modoc		156				156	156
Mono	66	36,667	1,782			38,449	38,515
Monterey		45				45	45
Nevada	116	43,828				43,828	43,944
Placer	573	4,341	7			4,348	4,921
Plumas	263	763	141			904	1,167
Riverside		172				172	172
Sacramento	5,639						5,639
San Bernardino	5	48,376	18,571	6,579		73,526	73,531
San Luis Obispo	2						2
Shasta	745	35,295	705,634	99		741,028	741,773
Sierra	389	6,738				6,738	7,127
Siskiyou	1,080	954				954	2,034
Stanislaus	1						1
Trinity	2,073	1,435				1,435	3,508
Tuolumne	76	40,290				40,290	40,366
Yuba	12,389	146				146	12,535
Merced, Siskiyou, and Stanislaus [a]	1,109						1,109
Total	35,379	289,119	833,672	220,229		1,343,020	1,378,399
Total, 1912	35,652	409,873	792,445	35,492	26,674	1,264,484	1,300,136
Increase (+), or decrease (−)	−273	−120,754	+41,227	+184,737	−26,674	+78,538	+78,263

[a] Dredge production combined to conceal output of single dredge.

From the siliceous ore and old tailings treated in California in 1913 the recovery of silver by amalgamation was 66,848 fine ounces, valued at $40,376; by cyanidation, 77,788 fine ounces, valued at $46,984; by chlorination, 13 ounces, valued at $8; and from smelting ore, 1,158,517 fine ounces, valued at $699,745, making a total from these sources of 1,303,166 fine ounces, valued at $787,113. As the silver production from deep mines was 1,343,020 fine ounces, valued at $811,184, the production from concentrates treated at custom mills and smelters was 39,854 fine ounces, valued at $24,071.

COPPER.

The mine production of copper in California in 1913 was 34,575,007 pounds, valued at $5,359,126, an increase of 1,123,335 pounds in quantity and a decrease of $160,400 in value. Copper was produced in Amador, Butte, Calaveras, El Dorado, Humboldt, Inyo, Kern, Lassen, Madera, Mariposa, Merced, Mono, Placer, Plumas, San Bernardino, Shasta, and Sierra counties. The heaviest production was, as usual, from Shasta County, where the increase for the year 1913 was 2,425,747 pounds in quantity and $129,806 in value as compared with 1912. Altogether there were 448,439 tons of copper ore treated, or 39,817 tons more than in 1912. In 1912 the tons of copper ore treated were 85,659 tons less than in 1911. Conditions regarding the smelter fume litigation in California remained about the same as in 1912, all the large copper smelting plants except those of the Mammoth Copper Co. and Mountain Copper Co., both of Shasta County, remaining idle. The copper ores in California in 1913 yielded in addition to the copper, 15,525.41 ounces of gold, valued at $320,939, and 833,672 ounces of silver, valued at $503,538.

LEAD.

The lead production in California in 1913 was 3,514,342 pounds, valued at $154,631, an increase of 2,369,611 pounds in quantity and $103,119 in value. From the lead ore was obtained also 1,319.47 fine ounces of gold, valued at $27,276, and 220,229 ounces of silver, valued at $133,018. The total value of the output of the lead-mining industry of the State in 1913, in lead and contained gold and silver, was $314,925. Most of the lead came from Inyo County, but some was also derived from San Bernardino, Butte, Kern, Placer, Plumas, Shasta, Sierra, and Trinity counties.

ZINC.

The recoverable production of zinc in California in 1913 was 1,057,485 pounds, valued at $59,219, as compared with 4,345,591 pounds, valued at $299,846 in 1912, a decrease for 1913 of 3,288,106 pounds in quantity and $240,627 in value. There were only two mines producing zinc in California in 1913, the principal one being in Inyo County, but a small quantity was derived from experimental tests of ore in Shasta County.

MINING AND METALURGICAL INDUSTRIES IN CALIFORNIA IN 1913.

The total value of the gold, silver, copper, lead, and zinc produced in California in 1913 shows an increase of $428,541, or 1.62 per cent. The greatest relative increase was in the lead, the value of which in-

creased $103,119, or 200.18 per cent, over the value for 1912. The gold increase was $693,480, or 3.52 per cent, the output having been $20,406,958, as compared with $19,713,478 in 1912. The deep mines of the State produced $11,570,781, or 56.70 per cent of the total gold yield in 1913. The increase of gold from deep mines for the year was $502,966, or 4.54 per cent, as compared with 1912. The placer mines produced $8,836,177 in gold, or 43.30 per cent of the total. The increase in placer gold was $190,514, or 2.20 per cent.

The silver increased in quantity by 78,263 ounces and in value $32,969. This increase was entirely due to the deep mines, as there was a small decrease in placer silver.

The output of $20,406,958 in gold in California was the largest in 31 years, the output in 1883 having been $24,316,873. In fact it is only the third time in 49 years that the output has exceeded $20,000,000. In 1864 the gold yield was $24,071,423, and it was not until 1880 that it reached $20,030,761, and it exceeded that again in 1883. So, with the exception of one year—1883—the gold output of the State in 1913 was higher that it has been since 1864. This record was made notwithstanding that the number of producing mines in the State fell off over 25 per cent in 1913, as compared with 1912. It is the operations carried on upon an extensive scale which are now producing the increased quantity of gold rather than the efforts of individuals or numerous small enterprises. The big deep quartz mines with their 50 and 100 stamp mills, treating hundreds of thousands of tons of ore, and the gold dredges handling millions of cubic yards of auriferous gravel, of so low a grade as to be unprofitable under any other system of mining, are responsible for sustaining and increasing the gold yield of California. In some of the deeper quartz mines they are working as good ore at depths of 3,000 and nearly 4,000 feet vertical as they found near the surface, and the dredgers are producing 91.56 per cent of the placer gold output from ground formerly considered worthless for mining, as being too low in gold content, having no "fall" or drainage and where water could not be applied advantageously under old systems. Since the commencement of dredging operations in the State 15 years ago the gold output from that source has been $63,505,485; and from an output of $206,302 in 1899 the annual dredge yield has increased to the sum of $8,090,294 in 1913.

It is notable that the gold output from the dredging operations of the State in 1913 was $660,339 more than it was in 1912, and that the dredges are now producing 39.64 per cent of the total gold yield and 91.56 per cent of the placer gold yield. This is a remarkable record for a form of the gold-mining industry only developed within recent years. Since 1902 the Oroville (Butte County) field has yielded $25,207,951 in gold without counting previous years, or $1,197,761 derived in the past four years from dredges in adjacent districts of the same county. The Marysville (Yuba County) field, from a yield of dredge gold of $25,736 in 1903, reached $2,420,455 in 1913, and a total from 1903 to 1912, inclusive, of $18,867,026. The Folsom (Sacramento County) dredging field, from a yield of $155,194 in 1902, produced $2,498,603 in 1913, or a total of $12,735,613 from 1902 to 1913, inclusive. It is a notable fact that this last-named field increased its dredge gold output by $825,806 in 1913 as compared with 1912. The Natomas Consolidated, of California, owns

most of the dredgers in this field, as well as three at Oroville, and its actual working profit in 1913, not counting interest on bonds, etc., was $992,366. The cost of production shows an increase from 4.463 cents per cubic yard in 1912 to 5.354 cents in 1913.

Under the heading "Production by counties," in this chapter, the details of the more important changes of metal-mine conditions are noted. The gold-mining industry is prosperous and the output is increasing, but the number of producing mines has decreased to a marked degree. This is largely due to the cessation of prospecting throughout the State, a condition prevailing in other Western States as well. The withdrawal of large tracts of land by the Government seems to have discouraged prospecting, even though, as in the case of forest reserves, the conditions for miners are not changed by the laws, although they may be in carrying out the regulations. Moreover, it seems no longer easy to obtain capital to develop prospects or small mines, investors seeming to look in other directions. Another factor lies in the changes in the handling of the water supply for mining, brought about through the purchase by hydroelectric power companies of the old mining ditches, flumes, reservoirs, etc., which were formerly owned by the water companies who supplied the mines. The old companies, depending largely on the miners as patrons, were liberal in their terms, granting credit until money could be obtained from the claims through the use of the water. The power companies not only use their water for generation of electric power, but supply towns where clear water is wanted, and also irrigation districts in the foothill and valley region. These companies now generally demand advance payment for water, and with this rule in force numbers of miners are unable to comply. Having more important consumers the miner is more or less ignored and consequently many small claims have been closed down. In one instance a power company uses 25 miles of the Bear River as a ditch to carry its water to the next power station and objects to mining in that section, as it muddies the water. The people in the towns supplied with water along the line also desire clear water. These conditions are naturally unfavorable to mining operations.

In this same portion of the chapter in the report of 1912 reference was made to a compromise arranged with extensive lode mines in Amador County and farmers in adjacent valley agricultural counties, whereby the various companies agreed to impound their quartz tailings and prevent them entering the streams if they could be exempt from litigation or injunction until December, 1914. This is a very important matter to the deep gold-mining interests of the State, as the result will be a precedent in other mining sections. In accordance with the agreement, the Kennedy Mining Co., of Jackson, Amador County, the largest ore producer in the county, purchased a tract of land and erected four elevating wheels 56 feet in diameter, each containing 176 buckets, by means of which the tailings are lifted a total height of 144 feet and transported in flumes a distance of 1,800 feet to a small valley. About 450 tons a day are crushed in the 100-stamp mill. The adjoining mine, the Argonaut, has its mill on a hillside below the shaft. The company is now to build a 50-stamp mill on top of a hill 455 feet above the shaft. The ore hoisted by the new 90-foot head frame is to be carried to the mill by a tramway, using 2-ton skips in balance, aided by an electric hoist near the

main shaft. The tailings from the plant will then flow by gravity to a site ample for about 25 years' storage. Both these places have been described and illustrated in the technical press.[1]

Having referred to the output of the principal placer fields of the State, in connection with dredge yield, it will be of interest to note generally the tonnage, yield, and average values per ton of the principal deep mine centers. In the Mother Lode region, Jackson and Sutter Creek, in Amador County, may be considered as one district, just as Grass Valley and Nevada City, in Nevada County, may be considered as one district. In the Jackson district are the largest producers in the Mother Lode. At these combined mines in 1913 there were 448,269 tons of ore treated, yielding $2,117,962 in gold, or $4.72 per ton; $13,402 in silver, or $0.03 per ton; making a total production of gold and silver of $2,131,364, or $4.75 per ton. In Grass Valley district there were 252,607 tons of ore treated, yielding $2,830,661 in gold, or $11.21 per ton; $26,082 in silver, or $0.10 per ton; a total production in gold and silver of $2,856,743, or $11.31 per ton. At Kennett, Shasta County, where the Mammoth Copper Company's mine and smelter are located, 280,657 tons of ore were treated from all the mines, yielding $222,988 in gold, or $0.79 per ton; $375,171 in silver, or $1.34 per ton; $3,118,271 in copper, or $11.11 per ton; making a total metal production of $3,716,430 in value, or $13.24 per ton.

Tables printed elsewhere in this chapter show in detail that the average values per ton in all metals of the different classes of ore mined and treated in California in 1913, were as follows: Siliceous ore, $5.66 per ton; copper ores, $13.58 per ton; lead ores, $23.11 per ton; and zinc ores, $32.48 per ton. Of the 2,495,958 tons of ore treated, 2,031,429 tons were siliceous.

In the section on production by counties in this report the details of mining work in the Mother Lode counties are given. A condensed statement of the record of these Mother Lode counties, including all deep mines in these counties, is given in the following table:

Tonnage of ore and value recovered in bullion in gold and silver mills, tonnage and value of concentrates produced, and total recovery, with average value per ton, in Mother Lode counties in California, 1913.

County.	Ore to gold and silver mills.			
	Quantity.	Gold in bullion.	Silver in bullion.	Average value in gold and silver recovered on plates per ton.
	Short tons.		*Fine oz.*	
Amador	615,167	$1,812,562	16,760	$2.96
Calaveras	359,294	389,710	3,959	1.09
El Dorado	16,766	27,653	229	1.66
Mariposa	15,054	149,971	1,973	10.04
Tuolumne	236,062	698,076	38,687	3.06
Total	1,242,343	3,077,972	61,608	2.51

[1] Description in Min. and Sci. Press, May 9, 1914, pp. 770-772.

Tonnage of ore and value recovered in bullion in gold and silver mills, tonnage and value of concentrates produced, and total recovery, with average value per ton, in Mother Lode counties in California, 1913—Continued.

County.	Concentrates produced.				Value of total recovery.	Value of total average recovery per ton.
	Quantity.	Gold.	Silver.	Average value in gold and silver per ton.		
	Short tons.		*Fine oz.*			
Amador	13,329	$1,025,779	11,174	$77.46	$2,855,213	$4.64
Calaveras	7,132	284,470	8,743	40.63	681,852	1.90
El Dorado	284	14,212	18	50.08	42,014	2.51
Mariposa	227	10,953	293	49.03	162,293	10.78
Tuolumne	7,447	264,667	1,603	35.67	987,078	4.18
Total	28,419	1,600,081	21,831	56.77	4,728,450	3.81

A comparison of this table with the corresponding one for the year 1912 shows a total decrease of tonnage for the five Mother Lode counties in 1913 of 57,645 tons of ore. El Dorado and Tuolumne counties alone show increase of tonnage.

In the Mother Lode counties in 1913 there were treated in gold and silver mills 1,242,343 tons of ore, yielding $4,728,450 in gold and silver, an average of $3.81 per ton, as compared with 1,299,988 tons treated in 1912, which yielded $4,803,935 in gold and silver, or an average of $3.69 per ton, and 1,377,084 tons in 1911, which yielded $4,910,358 in gold and silver, or an average of $3.57 per ton. From these figures it will be seen that, since 1911, there has been a gradual decrease in the total number of tons treated in the Mother Lode counties, as well as a gradual decrease in the total value of gold and silver recovered. The value per ton of the ore, however, has increased from $3.57 in 1911 to $3.81 per ton in 1913. This gradual increase in total average value per ton may be attributed to the corresponding increase in the average value of gold and silver recovered in bullion and the total average value in gold and silver of the concentrates produced. The average value of gold and silver recovered in the mills as bullion in 1913 was 11 cents per ton more than in 1912. The average value of gold and silver in the concentrates was $2.94 more per ton. The total average recovery was 12 cents per ton higher.

The total quantity of ore treated at gold and silver mills from the deep mines of the State in 1913 was 1,905,258, or 172,042 tons less than in 1912. Of the total ore milled 1,242,343 tons (65.20 per cent) came from the Mother Lode counties in 1913. Amador, the largest producer of the Mother Lode counties, produced 615,167 tons of milling ore, or 32.29 per cent of the total production of ore milled in the State in 1913, and 49.52 per cent of the ore milled in the Mother Lode counties.

In the report of 1912 a list was given of the reduction mills in California, with details of machinery, capacity, etc. It was not considered necessary to repeat this list for 1913, as the few changes made are noted in the report on the separate counties. An account also was given of the mining of black sand on the ocean beaches

and of the operations in dry washing camps, for which the reader is referred to the report of 1912.

The total tonnage, by kinds of ore sold or treated in each county of California in 1913, is shown in the following table:

Subdivision of tonnage of crude ore sold or treated in California in 1913, by counties, in short tons.

County.	Siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Total ore.
Alpine	9				9
Amador	640,312	281			640,593
Butte	13,555		4		13,559
Calaveras	359,360	54,646			414,006
El Dorado	16,776	22			16,798
Fresno	485				485
Humboldt		23			23
Imperial	10,479				10,479
Inyo	22,369	143	13,858	1,694	38,064
Kern	147,109	22			147,131
Lassen		21			21
Los Angeles	185				185
Madera	1,627	1,918			3,545
Mariposa	15,054	5,617			20,671
Merced	104	7			111
Modoc	441				441
Mono	21,942	11			21,953
Monterey	179				179
Nevada	276,306				276,306
Placer	17,679	4			17,683
Plumas	35,300	54			35,354
Riverside	780				780
San Bernardino	39,782	327	404		40,513
Shasta	92,273	385,343	1	129	477,746
Sierra	74,656				74,656
Siskiyou	3,508				3,508
Trinity	3,497				3,497
Tuolumne	236,062				236,062
Yuba	1,600				1,600
Total	2,031,429	448,439	14,267	1,823	2,495,958
Increase (+) or decrease (−)	−194,000	+39,817	+13,293	−4,649	−145,539
Average value per ton in gold and silver	$5.61	$1.84	$11.24		$4.96

Total yield and average value per ton, in gold and silver and in all metals, of the different classes of ore mined and treated in California in 1913.

Class of ore.	Tonnage.	Total value of gold and silver.	Total value in all metals.	Average value per ton of gold and silver.	Average value per ton in all metals.
	Short tons.				
Siliceous	2,031,429	$11,397,194	$11,475,261	$5.61	$5.66
Copper	448,439	824,477	6,090,696	1.84	13.58
Lead	14,267	160,294	329,765	11.24	23.11
Zinc	1,823		59,219		32.48
Total	2,495,958	12,381,965	17,954,941	4.96	7.19

The subdivision of tonnage and production of gold and silver in California in 1913, according to methods of treatment, is shown in the table following.

Subdivision of tonnage and production of gold and silver in California in 1913, according to methods of treatment, by counties.

County.	Ore to gold and silver mills.			Concentrates produced.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*		*Fine ounces.*
Alpine	9	$537	6			
Amador	615,167	1,812,562	16,760	13,329	1,025,779	11,174
Butte	13,553	35,012	137			
Calaveras	359,294	389,710	3,959	7,132	284,470	8,743
El Dorado	16,766	27,653	228	284	14,212	18
Fresno	484	2,803	24			
Humboldt						
Imperial	4,004	6,102	32			
Inyo	22,336	212,248	6,285			
Kern	146,906	637,579	8,255	15	8,100	358
Lassen						
Los Angeles	185	2,322	45			
Madera	1,625	13,874	104			
Mariposa	15,054	149,971	1,973	227	10,953	293
Merced						
Modoc	430	5,772	139			
Mono	9,219	51,075	1,530			
Monterey	179	6,491	45			
Nevada	267,761	2,458,290	26,684	3,454	402,819	13,724
Placer	17,667	82,068	3,177	21	976	786
Plumas	35,299	78,804	615	72	2,071	147
Riverside	754	12,089	166			
San Bernardino	12,639	157,414	3,891			
Shasta	48,903	571,238	4,782	408	35,207	695
Sierra	72,456	916,088	6,220	246	13,194	497
Siskiyou	3,508	49,458	954			
Trinity	3,398	60,092	1,159	17	1,208	8
Tuolumne	236,062	698,076	38,687	7,447	264,667	1,603
Yuba	1,600	31,917	146			
Total	1,905,258	8,469,245	126,003	32,652	2,063,656	38,046
Average value per ton		$4.44	$0.04		$63.20	$0.70

County.	Crude ore to smelter.			Old tailings treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*		*Fine ounces.*
Alpine						
Amador	292	$1,439	1,114	25,134	$29,068	578
Butte	6	1,054	179			
Calaveras	54,712	61,394	86,555			
El Dorado	32	331	26			
Fresno	1	43	1			
Humboldt	23		18			
Imperial				6,475	25,598	124
Inyo	15,728	25,062	220,294			
Kern	225	1,704	10,991			
Lassen	21		3			
Los Angeles						
Madera	1,920	315	2,570			
Mariposa	5,617	6,591	10,002			
Merced	111	2,255	152			
Modoc	11	289	17			
Mono	2,583	5,978	22,104	10,151	84,719	14,815
Monterey						
Nevada	45	3,575	36	8,500	36,174	3,384
Placer	15	706	238	1	21	147
Plumas	55	918	142			
Riverside	1	124	1	25	288	5
San Bernardino	20,906	178,041	68,417	6,968	20,259	1,218
Shasta	428,786	538,151	735,389	57	80	162
Sierra				2,200	1,643	21
Siskiyou						
Trinity	99	12,060	268			
Tuolumne						
Yuba						
Total	531,189	840,030	1,158,517	59,511	197,850	20,454
Average per ton		$1.58	$1.32		$3.32	$0.21

Average recovery from bullion and concentrates: Gold, $5.52: silver, $0.05.

Reports were received from 796 producing mines in California in 1913, as shown in the following table:

Number of producing mines in California, classified by chief product in 1913, by counties.

County.	Placer mines.					Deep mines.						Total mines reporting product.
	Hydraulic.	Dredging.	Drift.	Surface.	Total.	Gold.	Copper.	Silver.	Silver-lead and lead.	Zinc.	Total.	
Alpine						1					1	1
Amador			7	3	10	17	2				19	29
Butte	3	25	12	14	54	6			1		7	61
Calaveras	2	4	6	9	21	23	2				25	46
Del Norte	2		1	2	5							5
El Dorado	2		9	7	18	7	1				8	26
Fresno						3					3	3
Humboldt	14			1	15		1				1	16
Imperial						2					2	2
Inyo						11	7	1	24	1	44	44
Kern				3	3	33	1	2			36	39
Lassen							1				1	1
Los Angeles						2					2	2
Madera				1	1	3	4				7	8
Mariposa				5	5	11	4				15	20
Merced		1			1	1	1				2	3
Modoc						3					3	3
Mono				1	1	5	1				6	7
Monterey						3					3	3
Nevada			5	3	8	27					27	35
Placer		3	15	8	26	12	1				13	39
Plumas	7		7	12	26	9	4				13	39
Riverside						4					4	4
Sacramento		12	3		15							15
San Bernardino				1	1	26	16	3	8		53	54
San Luis Obispo				1	1							1
Shasta		2	1	6	9	25	5		1	1	32	41
Sierra	6		11	7	24	17					17	41
Siskiyou	41	1	1	15	58	16					16	74
Stanislaus		1		1	2							2
Trinity	31	2	1	16	50	22					22	72
Tuolumne			5	1	6	26					26	32
Yuba		12	1	13	26	2					2	28
Total	108	63	85	130	386	317	51	6	34	2	410	796

PRODUCTION BY COUNTIES.[1]

AMADOR COUNTY.

Number of mines producing in Amador County, Cal., quantity of ore sold or treated in 1905–1913, and total gold, silver, and copper.

Year.	Number of mines producing.	Quantity.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	36	649,693	$2,420,161	21,420	10,000	$2,434,659
1906	26	579,599	2,260,376	21,760	8,648	2,276,624
1907	36	444,341	2,116,182	20,477	5,300	2,130,757
1908	34	422,155	1,876,174	24,980	55,788	1,896,777
1909	51	480,674	2,298,785	32,118	113,995	2,330,305
1910	50	577,934	2,646,246	36,883	151,480	2,685,401
1911	50	656,806	2,832,395	54,526	227,848	2,889,775
1912	44	737,148	2,796,194	52,093	175,542	2,857,195
1913	29	640,593	2,901,898	29,962	19,015	2,922,942
Increase (+) or decrease (−) in 1913	−15	−96,555	+105,704	−22,131	−156,527	+65,747

[1] For reference to United States Geological Survey publications on the mining districts of California, see Hill, J. M., The mining districts of the western United States: U. S. Geol. Survey Bull. 507, 1912.

There were 15 fewer mines producing in Amador County in 1913 than there were in 1912, and the tonnage of ore decreased by 96,555 tons, yet the output of gold was increased by $105,704. There was a falling off in the yield of silver and copper, but the total increase in value of the metals for the year in the county was $65,747. Amador still continues to lead all other counties of the State in tonnage of ore treated, with 640,593 tons in 1913, exceeding the next county in rank in this respect, Shasta, by 162,847 tons. Amador is now the second in rank of the gold-producing counties of the State, having been displaced from its leading position in 1912 by Nevada County, which exceeded it in 1913 by $16,835. The quantity of gold produced in Amador County in 1913 was 140,379.31 fine ounces, valued at $2,901,898. The value of the silver was $18,097, and of the copper $2,947. There were 10 productive placer mines in the county in 1913 and 19 deep mines, 29 in all.

Of the total output of ore, 281 tons of copper ore and 11 tons of siliceous ore were shipped to the smelter, and 615,167 tons (96.03 per cent of the total tonnage) was treated in the gold and silver mills. From this milling ore $1,812,562 in gold and 16,760 ounces of silver, valued at $10,123, was saved as bullion, an average gold value of $2.95 per ton, and an average silver value of 0.016 cent per ton. From this milling ore was obtained 13,329 tons of concentrates, which yielded $1,025,779 in gold, an average of $76.96 per ton, and 11,174 ounces of silver, valued at $6,749, an average of 50 cents per ton, a total average value of $77.46 per ton. The extraction of gold from bullion and concentrates combined was $2,838,341, an average of $4.61 per ton, and the recovery of silver was $16,872, an average value of $0.03 per ton. The value of total yield of gold and silver from milling ore was therefore $2,855,213, an average value of $4.64 per ton. In addition there were 25,134 tons of old tailings treated, yielding $29,068 in gold and 578 ounces of silver, valued at $349, a total of $29,417, or an average per ton in gold of $1.16 and in silver of $0.01. The ore shipped to smelters yielded $1,439 in gold and 1,114 ounces of silver, valued at $673, in addition to the copper. The yield of the placers in the county was 1,598.79 fine ounces of gold, valued at $33,050, and 336 ounces of silver, valued at $203. Of the placers, seven were drift mines and three surface sluicing mines. The increase of gold from placers in 1913 was $18,322 as compared with 1912.

At Amador City, the Bunker Hill Consolidated is the most important of the deep-mine producers. It is operated through a 2,500-foot incline shaft, of which 400 feet were sunk in 1913. In the tailings plant connected with the mine the tailings are separated into two products. The sand is cyanided direct and the slimes concentrated on slime tables before treatment. The Original Consolidated Amador Mines Co. operates its property by means of an 800-foot incline shaft and 10,000 feet of drifts and raises. Some 2,500 feet of drifts and raises were cut in 1913. The Keystone Mines (Inc.), continued prospecting in 1913, reopened the 1,200-foot level, and made raises from the 2,600-foot level, but there was no production for the year. The Fremont Consolidated, at Drytown, works as one property the Gover, the North Gover, the Loyal Lode, and the Fremont mines. The property was operated the entire year, but no sinking was done. At Ione, the Ione Coal & Iron Co. operated until Novem-

ber, when it was closed down. The Amador Gold Mining Co., at Defender, was developing for most of the year 1913, but made some production.

The most important deep gold mines of the State in tonnage and yield are at Jackson and Sutter Creek, which may be considered as one district. At the Argonaut, at Jackson, the 60-degree incline shaft is 4,185 feet deep. The Hardenburg, an old mine, was reopened and became productive in February, 1913. The Kennedy, one of the most productive deep mines in California, and the deepest, has its main shaft sunk to a depth of 3,896 feet. At this mine tailings wheels have been installed to provide for the storage of tailings from the mill. In the vicinity of these districts there is more or less gold in small lots purchased from prospectors, Indians, etc. The Central Eureka, at Sutter Creek, has an incline shaft 3,035 feet deep. During the year a shaft of an adjoining mine caved, forcing this company to quit work, but the mine was eventually unwatered and retimbered, and the sinking of shaft and other development work was commenced. The East Eureka, at the same place, was operated for five months in 1913 and was productive. The South Eureka, which is equipped with a 100-stamp mill, is the largest producer at Sutter Creek. At Plymouth, the Plymouth Consolidated group was under development the entire year, and after the close of the year erected a 300-ton amalgamating and concentrating mill. At Volcano the Cleveland Consolidated is operating an important drift mine, and there are some other drift and sluicing mines operating on a small scale.

BUTTE COUNTY.

Number of mines producing in Butte County, Cal., quantity of ore sold or treated, 1905–1912, and total gold, silver, copper, and lead produced.

Year.	Number of mines producing.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	82	1,058	$2,590,886	10,907	.....	.....	$2,599,244
1906	63	682	3,016,747	16,199	.....	.....	3,027,600
1907	72	.....	2,786,840	13,587	.....	.....	2,795,807
1908	75	1,215	3,139,398	23,978	.....	.....	3,152,106
1909	49	1,316	2,987,079	13,856	.....	.....	2,994,284
1910	76	13,578	2,487,791	11,851	.....	659	2,494,220
1911	82	2,575	2,323,396	9,627	.....	.....	2,328,498
1912	77	3,326	2,346,229	9,053	.....	.....	2,351,796
1913	61	13,559	2,269,849	8,548	30	362	2,275,033
Increase (+) or decrease (—) in 1913.	—16	+10,233	—76,380	—505	+30	+362	—76,763

In 1913 Butte County showed a decrease in gold production of $76,380 and in silver of 505 ounces compared with 1912. There were 16 fewer producing mines than in 1912. The productive mines of the county comprise 3 hydraulic, 25 dredges, 12 drift, and 14 surface and 7 deep mines, a total of 61. The dredges produced $2,122,926 in gold in 1913 and $2,271,996 in 1912, a loss of $149,070 for 1913. There were 3 less dredges in operation in the county in 1913 than in 1912. The hydraulic mines of the county produced $2,334 less gold in 1913 than in 1912, the drift mines $12,349 more,

and the sluicing mines $47,910 more. The total output of gold from placers of all kinds in 1913 was $2,233,783, as compared with $2,324,928 in 1912, a loss of $91,145. The deep-mine gold output was $36,066 in 1913, as compared with $21,301 in 1912, a gain of $14,765. The total silver output for 1913 was 8,548 ounces, valued at $5,163, a nominal increase over 1912. Butte is now the third county in rank in annual yield of gold from dredging, having been surpassed by both Sacramento and Yuba counties. The following table shows the gold output from the Oroville field for several years past, with the annual decrease or increase:

Mine production of gold of Oroville dredging district, California, 1903–1913, with increase (+) or decrease (−), by years.

Year.	Production.	Increase (+) decrease (−).
1903	$1,329,998	
1904	1,632,507	+$302,509
1905	2,261,887	+ 629,380
1906	2,768,782	+ 506,895
1907	2,697,092	− 71,690
1908	3,043,151	+ 346,059
1909	2,743,232	− 299,919
1910	2,099,628	− 643,604
1911	1,987,294	− 112,334
1912	2,080,229	+ 92,935
1913	1,918,050	− 162,179

This table applies to the dredges in the Oroville district proper, there now being in Butte County 4 other dredges in "outside" districts. The combined output of these outside dredges in 1913 was $204,876, as compared with $191,767 in 1912, with $264,470 in 1911, and with $289,607 in 1910.

In 1913 the following companies were operating in the Oroville field, each with one machine unless otherwise noted: Boston & California; Boston & Oroville; El Oro (2 dredges); Gold Run, Indiana; Oro Vista; Natomas Consolidated of California (3 dredges); Ophir (2 dredges); Oroville Dredging (Ltd.) (no dredges); Oroville Gold Dredge & Exploration Co. (2 dredges); Oro Water, Light & Power Co. (4 dredges); Pacific; Pennsylvania; Viloro Syndicate. Of the two dredges of the Ophir one was inoperative in 1913, although enumerated in the count of dredges in the field. The Pacific had 1 at work in 1913 and 3 in 1912. There were, therefore, 21 dredges in the Oroville field proper and 4 in the outside districts of the county. The Boston & Oroville, Boston & California, and Oroville Gold Dredging & Exploration Co. worked under those names for nine months of 1913, when they were merged into the Oroville Dredging (Ltd.), so that they are no longer in existence as separate corporations. Their 4 dredges and other properties now belong to the Oroville Dredging (Ltd.). The companies at Butte Creek and Honcut, outside the Oroville district, are the Butte Creek Consolidated, Drexler, Kentucky Ranch, and Honcut.

As to other placer operations in the county in 1913, some hydraulicking is being done at Cherokee and some drifting at Coutolenc, Clipper Mills, Inskip, Magalia, and Nimshew. Smaller operations in sluicing are being carried on at Brush Creek, Clipper Mills, De Sabla, Inskip, and Stirling City. There are no large producers among any of these.

Among the few deep mines of the county which are producing are the Forbestown Consolidated, at Forbestown; Triumph, at Lumpkin; and Alder Springs, at Nimshew.

The Royal Drift Mining Co., at Berdan, is prospecting for the river channel. The Crystal Hill at Coutolenc has ceased drifting operations, as no pay was found. Bean & Corbiere at Clipper Mills are building a débris dam to store hydraulic tailings. The Fort Sumpter at John Adams closed down, being unable to handle the water. The Nugget Gravel Mining Co., at Lovelock, started drifting operations in 1913, and the Indian Spring Channel did not reach gravel until after the close of the year.

CALAVERAS COUNTY.

Number of mines producing in Calaveras County, Cal., quantity of ore sold or treated in 1905–1913, and total gold, silver, and copper.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	56	547,972	$1,780,485	105,693	3,666,810	$2,416,345
1906	48	583,207	1,644,234	110,597	5,082,320	2,699,221
1907	77	295,441	1,097,974	82,454	4,386,243	2,029,643
1908	59	481,669	1,378,511	118,353	4,473,030	2,031,678
1909	94	566,665	1,440,511	137,342	5,416,315	2,216,050
1910	71	436,263	1,147,705	155,248	7,302,331	2,158,935
1911	78	482,983	1,112,315	126,476	5,681,200	1,889,497
1912	70	430,128	962,145	115,037	6,089,819	2,037,713
1913	46	414,006	1,175,208	101,120	5,823,226	2,138,884
Increase (+) or decrease (−) in 1913	−24	−16,122	+213,063	−13,917	−266,593	+101,171

Although there was a decrease of 24 in the number of producing mines in Calaveras County in 1913, as compared with 1912, a decrease of 16,122 tons in the ore, of 13,917 ounces in the silver, and of 266,593 pounds in the copper, yet, as the gold yield increased by $213,063, the total value of metals for 1913 shows a gain of $101,171. The value of the copper output of the county in 1913 was $902,600, as compared with $1,004,820 in 1912, a decrease of $102,220. In 1913 productive mines to the number of 46 reported 23 deep gold mines, 2 copper mines, and 2 hydraulic, 4 dredges, 6 drift, and 9 surface placers. The average value of the 359,294 tons of milling ore treated at gold and silver mills in the county in 1913 was only $1.90 per ton in gold and silver, compared with $1.88 in 1912. The average is much the lowest of any of the mother-lode counties. The output of ore sold or treated in Calaveras County in 1913 was 414,006 tons, yielding 35,583.39 fine ounces of gold, valued at $735,574; 99,257 fine ounces of silver, valued at $59,951; and 5,823,226 pounds of copper, valued at $902,600. The output of placer gold was 21,267.29 fine ounces, valued at $439,634, and 1,863 fine ounces of silver, valued at $1,125. The output of the county in 1913 in gold, silver, and copper was valued at $2,138,884.

There were 359,294 tons of ore treated at gold and silver mills, from which was obtained $389,710 in gold in bullion, or $1.08 per ton, and 3,959 fine ounces of silver, valued at $2,391, or 1 cent per ton. The total saving in bullion was valued at $392,101, or $1.09

per ton. From this 359,294 tons of ore were obtained 7,132 tons of concentrates, yielding $284,470 in gold, and 8,743 fine ounces of silver, valued at $5,281, an average of $39.89 in gold and $0.74 in silver, or a total average value of $40.63 per ton. The milling ore yielded $676,571 in gold, the average recovery in gold per ton being $1.88; in silver the average recovery was 2 cents per ton; the total gold and silver recovery was, therefore, valued at $1.90 per ton. There were 54,712 tons of smelting ore sold or treated, yielding $61,394 in gold, and 86,555 fine ounces of silver, valued at $52,279, or an average value per ton of $1.12 in gold, and $0.96 in silver, or $2.08 per ton in gold and silver, and 5,823,226 pounds of copper, valued at $902,600. The total value of the smelting ore was $1,016,273, or $18.58 per ton.

Angels is the leading mining section of the county. In 1913 the deep mine output of the camp was $405,621 in gold and $4,044 in silver, as compared with $405,803 in gold and $5,684 in silver in 1912. The Angels mine was operated full time during the year, but the mill only half capacity full time. The Brown-Smith-Ryland, Dolling, and the Finnigan mines are not large producers. The Lightner Mining Co., successor to the Lightner Gold Mining Co., was operated after August only, being idle the earlier portion of the year. The Utica has always been the largest producer in the camp and has three shafts to a depth of 1,700 feet each. The Utica, Stickle, and Gold Cliff mines are included in the corporation. The most productive mine in the county is that of the Penn Mining Co., at Campo Seco, the values being mainly in copper, with considerable gold and silver. The mine is equipped with a 200-ton smelting plant. The blast furnace was operated one month in 1913 and the reverberatory furnaces 12 months. The Calaveras Copper Co., at Copperopolis, is among the largest producers of the county. Copper sulphide ores from the mine are treated at custom smelters. The Melones Mining Co. is one of the large producers of Calaveras County and has a 100-stamp mill and a 25-ton cyanide plant. At Mokelumne Hill the principal quartz mines are the Frankmont, Green Mountain, and Quartz Glen. The Comet, Josephine, and Mohawk are the productive deep mines at Railroad Flat. At West Point there were several quartz properties with a small output in 1913. The productive placers in the county are at Comanche, Felix, Jenny Lind, Mokelumne Hill, Railroad Flat, San Andreas, and Valley Springs. At Comanche the Oro Water, Light & Power Co. is operating a dredge, and at Jenny Lind are situated the dredge properties of the Butte Dredging Co. Calaveras Dredge Co., and Isabel Gold Dredge Co. There was a material increase in dredge gold output at Jenny Lind in 1913 as compared with 1912.

Among the nonproducing properties of Calaveras County the Standard Amalgamated Exploration Corporation, at Angels, completed a new 20-stamp mill and is installing a 50-ton cyanide plant. At the Nuner drift mine, Mokelumne Hill, a triple discharge 3-stamp mill to crush the cemented gravel has been erected, but it was not started until after the end of the year. At the Big Bend, Mountain Ranch, a tunnel to tap the channel was run in 1913.

ELDORADO COUNTY.

Number of mines producing in Eldorado County, Cal., quantity of ore sold or treated in 1905–1913, and total gold, silver, and copper.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	58	36,708	$385,596	3,253	160,000	$412,521
1906	61	31,818	431,746	4,015	.....	434,436
1907	61	33,781	319,177	3,486	.....	321,478
1908	64	10,521	342,033	10,385	.....	347,537
1909	48	27,431	238,284	2,498	.....	239,583
1910	64	17,383	171,304	1,791	.....	172,271
1911	56	11,444	133,967	1,905	.....	134,977
1912	51	8,871	105,565	1,371	.....	106,408
1913	26	16,798	62,688	414	703	63,047
Increase (+) or decrease (−) in 1913	−25	+7,927	−42,877	−957	+703	−43,361

Eldorado, which is one of the five mother lode counties in California, in 1913 produced 3,032.53 fine ounces of gold, valued at $62,688, and 414 fine ounces of silver, valued at $250, together with 703 pounds of copper, valued at $109, a total of $63,047. The ore treated at gold and silver mills, amounting to 16,766 tons, yielded in bullion $27,653 in gold, or an average of $1.65 per ton, and 229 ounces of silver, valued at $138, or an average of $0.01 per ton, the total recovery in bullion being valued at $27,791, or an average per ton of $1.66 in gold and silver. There were 284 tons of concentrates derived from the milling ore which yielded $14,212 in gold and 18 ounces of silver, valued at $11, a total value of $14,223, or $50.08 per ton in gold and silver. The milling ore yielded, therefore, in bullion and from the concentrates a total of $41,865 in gold, or an average per ton of $2.50, and silver valued at $149, or $0.01 per ton, or a total value of gold and silver of $42,014, or $2.51 per ton.

The placer mines of the county yielded 991.30 fine ounces of gold, valued at $20,492, and 142 ounces of silver, valued at $86. Of the gold, $2,851 was derived from hydraulic mines, $12,866 from drift mines, and $4,775 from 7 surface placers. There were 26 producing mines in the county in 1913, of which 18 were placer and 8 were deep.

The Cranes Gulch and Homestead were small producing deep mines at Georgetown, as were the Central El Dorado Gold Mining Co., Dutch Bund, and Hudson & Gamble, at Placerville. The Guilford, at the same place, was operated for 10 months of the year and is equipped with a 15-stamp mill. The productive placers were the Blue Rock, Donaldson & Victor group, Gold Bug and Kelliher, at Georgetown; Bordt, at Greenwood; some small mines at Josephine; Jinkerson, at Indian Diggings; Hosking, Klondike, Ideal, and Placerville Gold Mining Co., at Placerville; Pilot Knob, at Rescue; some small mines at Shingle; and Fort Jim, Kumfa-Carpender, and a few others at Smith Flat. There are very few either productive deep or placer mines in the county at present, many of the well-known mines being idle. Replies were received from 85 nonproductive mines which were either under development or idle.

DEL NORTE AND HUMBOLDT COUNTIES.

There were no deep mines productive in Del Norte County and the few hydraulic, drift, and sluicing mines are all near Crescent City. One of these is quite an extensive beach sand mine; but it was only operated for one month in 1913. The yield of the county was $2,498 in gold and 27 ounces of silver, valued at $16, a total of $2,514.

Humboldt County has only one deep mine, and that was a producer of copper, but not of gold. The placers are almost entirely worked on the hydraulic system, and are mainly at or near Orleans, although there are a few at Weitchpec. The total output of gold in the county in 1913 was $25,611, and of silver 218 ounces, valued at $132, a total value for gold and silver of $25,743. The producing hydraulic mines at Orleans are the Croton Bar, California Mining & Dredging Syndicate, Independence, Jungle, Little Klondike, Orcutt, Pearch, Red Cap, Rocky Point, Rosalino, Rough & Ready, and Salstrom; at Weitchpec, the Klamath River Mining Co. and the Weitchpec Bar hydraulic mines.

INYO COUNTY.

Number of mines producing in Inyo County, Cal., quantity of ore sold or treated in 1905–1913, and total gold, silver, copper, lead, and zinc.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	24	8,907	$91,501	84,622	151,606	447,723	.....	$187,307
1906	16	3,401	19,449	19,937	4,145	208,018	.....	45,464
1907	17	17,684	57,241	67,333	15,587	2,596,399	233,550	256,186
1908	25	39,440	308,873	58,302	3,690	1,110,952	.....	386,920
1909	34	79,625	457,846	90,609	31,722	1,490,649	.....	573,185
1910	33	52,963	408,509	239,982	58,017	2,866,894	.....	671,614
1911	50	101,662	574,945	86,185	29,504	1,329,756	2,624,719	833,759
1912	51	70,615	369,758	73,685	45,033	997,999	4,345,591	767,261
1913	44	38,064	237,310	226,579	114,213	3,246,432	963,571	588,670
Increase (+) or decrease (−) in 1913	−7	−32,551	−132,448	+152,894	+69,180	+2,248,433	−3,382,020	−178,591

There were 44 productive deep mines in Inyo County in 1913, but no placers. Of the deep mines 11 were gold, 7 copper, 1 silver, 24 silver-lead and lead, and 1 zinc. The total value of the output for 1913 was $588,670, which is $178,591 less than in 1912. The value of the gold output was $237,310. The value of the silver was $136,854; of the copper, $17,703; of the lead, $142,843; and of the zinc, $53,960. The greatest increase in value was that of the lead, which was $97,933; the value of the silver increased $91,538; and that of copper increased $10,272. There was a decrease of $132,448 in gold and of $245,886 in the value of the zinc in 1913.

There were treated in 1913 in Inyo County 38,064 short tons of ore, of which 22,369 tons were siliceous ore, 143 tons were copper ore, 13,858 tons were lead ore, and 1,694 were zinc ores. The deep mines in 1913 yielded 11,479.87 fine ounces of gold, valued at $237,310. The silver yield was 226,579 fine ounces, valued at $136,854. Of the gold, 10,311.47 fine ounces, valued at $213,157, were obtained from

siliceous ore; from copper ores were obtained 62.21 fine ounces, valued at $1,286; and the lead ores yielded 1,106.19 fine ounces, valued at $22,867. There was no production of gold reported from the zinc ore. The silver production from the siliceous ore was 6,814 fine ounces, valued at $4,116; from the copper ores, 6,381 fine ounces, valued at $3,854; and from the lead ores, 213,384 fine ounces, valued at $128,884. The siliceous ores, therefore, yielded $217,273 in gold and silver; the copper ores, $5,140; and the lead ores, $151,751—a total of $374,164 in gold and silver for the county.

The Lucky Strike and the Panamint Consolidated are small producing deep mines at Ballarat, as are the Fish Springs Hill, and a few other lead mines at Big Pine. A small quantity of lead ore was derived from the Huntington claim of the White Mountain Mining Co., at Laws. The Christmas Gift, at Darwin, yielded a considerable quantity of lead and silver, and at the same place are the Custer, Lone Jack, Long, New Coso, Rip Van Winkle, and Silverite mines. The producers at Independence were the Black Eagle, Birthday, and Independence, and at Keeler were the Domingo, Ella, Shady, Golden Gate, Gordon, Independent Lead-Silver Mining Co., Newsboy, Robin Hood, Spear Bros., Ventura, and Cerro Gordo [1] Mining Co., the latter being the largest of the few zinc producers in the State. The Nellie H, at Lone Pine, made a small yield. The Skiddoo Mines Co., at Skiddoo, was only operated four months in the year, owing to the freezing of the water-supply line and the burning of the 15-stamp mill in May, 1913. A new 10-stamp mill has been erected. In addition to the company's operations some leasing is also being done at these mines. The mines making an output at Tecopa were the Arcturus, Blue Dick, Silver Rule, and Tecopa Consolidated Mining Co., the last operating both the Gunsite and the Noonday mines and shipping its ore to Salt Lake City for treatment. The Keane Wonder is among the larger producers of the county.

The railroad to Searles Lake recently completed will help the Ballarat section of Inyo County, and the freight haul will be reduced by 32 miles. The Blue Bell Co., at Darwin, owning the Argus and California mines, carried on development work the entire year, but there was no production. Considerable development was also done on the Estella, or Morning Star group at Keeler, but no ore was treated. The Ironsides, at Lone Pine, expects to ship ore again in 1914, but made no output in 1913. The St. Ives was worked most of the year, but there was no output.

[1] Knopf, Adolph, Mineral Resources of the Inyo and White Mountains, California: U. S. Geol. Survey Bull. 540, pp. 81–120, 1914.

KERN COUNTY.

Number of mines producing in Kern County, Cal., quantity of ore sold or treated in 1905–1913, and total gold, silver, copper, and lead.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	46	252,776	$1,121,370	170,469	.....	.....	$1,224,333
1906	36	146,076	806,117	193,288	.....	.....	935,620
1907	40	236,853	878,798	130,353	.....	.....	964,831
1908	44	259,968	827,087	182,170	144	.....	923,656
1909	53	242,104	654,799	195,488	.....	.....	756,432
1910	51	197,550	619,974	64,891	.....	569	655,040
1911	53	180,687	557,471	11,005	33,224	600	567,484
1912	44	168,226	830,420	18,667	1,064	20,011	842,976
1913	39	147,131	649,712	19,621	3,432	159	662,102
Increase (+) or decrease (−) in 1913	−5	−21,095	−180,708	+954	+2,368	−19,852	−180,874

Of the total of 39 mines reporting product in Kern County in 1913, 3 were surface placers, 33 were deep gold mines, 1 was a copper mine, and 2 were silver mines. The total gold production of the county in 1913 was 31,429.82 fine ounces, valued at $649,712, as compared with 40,171.57 fine ounces, valued at $830,420 in 1912, a decrease in quantity of 8,741.75 fine ounces and in value of $180,708. The value of the silver was $11,851, as compared with $11,480 in 1912—a slight increase of $371; the copper output showed an increase in quantity of 2,368 pounds and in value of $356; and the lead, a decrease of $893 in value.

There were treated 147,109 tons of siliceous ore in 1913, of which 146,906 tons were treated at gold and silver mills and 203 tons were sent to smelters; there were also 22 tons of copper ore sent to smelter—a total output of 147,131 short tons. The yield in bullion from the 146,906 tons of ore treated at gold and silver mills was $637,579 in gold, an average of $4.34 per ton, and 8,255 fine ounces of silver, valued at $4,986, a total bullion value of $642,565 in gold and silver, with an average value per ton of $4.37. From this ore were derived 15 tons of concentrates yielding $8,100 in gold, and 358 fine ounces of silver, valued at $216, a total value of $8,316 in gold and silver, with an average value per ton of $554.40. The 225 tons sent to smelter yielded $1,704 in gold and 10,991 fine ounces of silver, valued at $6,639, a total value of $8,343 in gold and silver, or an average of $37.08 per ton in gold and silver. The total yield of the county in gold and silver from deep mines was $659,224, an average of $4.48 per ton of ore treated. Three placers yielded 112.67 fine ounces of gold, valued at $2,329, and 17 fine ounces of silver, valued at $10; these 3 mines were all surface or sluicing mines.

The most productive district in this county is Randsburg [1] (which includes Johannesburg). In 1913 the mines in these camps produced 135,501 tons of ore, yielding $504,698 in gold and $3,304 in silver as well as 159 pounds of lead, valued at $7, a total value of $508,009 as compared with a total of $748,223 in 1912 and of $509,696 in 1911

[1] Hess, F. L., Gold mining in the Bandsburg quadrangle, California: U. S. Geol. Survey Bull. 430, pp. 23–47, 1910.

This was a decrease of $240,214 for the year 1913 as compared with 1912, and largely accounts for the falling off in yield of the county. The Sierra Mining Co. is the only producer at Johannesburg. Of the larger producers at Randsburg the Consolidated Mines Co. obtained all its production from the Good Hope claim. All the work in 1913 on the Gold Brick was done by lessees. The Windy was operated throughout the year, but the workings are quite shallow. The most important mine in the district—and in Southern California—is the Yellow Aster, which is worked entirely by the "glory hole" system. The 100-stamp mill was operated for 11 months but the 30-stamp mill did not run after April 5, owing to trouble with one well and pump. There are about 15 miles of underground workings in this property. The gold is saved entirely by "free milling" over plates alone. Among other deep producers at Randsburg are the Alameda, Big Butte, Garfield, Josephine, Lucky Star & Margenetta, Phoenix, Santa Ana, and Stanford. As to the nonproducers at Randsburg the Little Butte will resume operations in 1914. On the Sidney group development work only was done. At the Golden Jack Rabbit, Caliente, an arastre has been operated to demonstrate values. The Kern County Tonopah Mining Co. at the same place shipped silver ore to the Selby smelter. At Havilah the King Solomon and the Lone Star were the only producers. The Early Sunrise at Isabella is developed by a 1,300-foot tunnel and was worked by a small force during the year. The Mammoth Mountain Mining Co. is operated by a 1,500-foot adit and a 200-foot winze. The 10-stamp amalgamating and concentrating mill was moved to the mine portal and started December 1. The Keys Mining & Milling Co. completed a new 5-stamp mill and concentrator in August, 1913. The Mojave Consolidated Gold Mines, at Mohave, has an incline shaft 900 feet deep and numerous shallow shafts on its properties, which consist of the Desert Queen, Yellow Rover, Golden Carrier, and Exposed Treasure. The company has a 125-ton amalgamation, concentration, and cyanide plant, of which a 60-ton unit was used in 1913, and the plant was overhauled so that it could be worked to full capacity. R. P. Sharpe, the superintendent, sends the following memorandum: "Development on 900-foot level, 80 feet below water level, disclosed redeposition of gold, occurring as crystalline—extremely rare." At Loraine are the Barbarossa and the Kramer Consolidated. On the Tropico, at Rosamond, a complete cyanide plant was installed in 1913, including sand and slime plants. Operations were commenced in April and continued intermittently for the remainder of the year. The Blue Mountain and the Colorado mines were small producers at White River, as was the Greenback Copper Co. at Woody.

The few placers in Kern County are the Keyesville, at Isabella; Bonanza & Deep Diggings, at Ricardo; and a few small mines at Woody.

MADERA COUNTY.

The 7 deep mines of Madera County (there are only a few unimportant placers) made a production of 3,545 tons of ore in 1913, which yielded 686.39 ounces of gold, valued at $14,189; 2,674 ounces of silver, valued at $1,615; and 531,819 pounds of copper, valued at $82,432. Adding $300 in gold and 3 ounces of silver valued at $2 from small sluicing mines at O'Neals, the total value of the metal

output of the county in 1913 was $98,538. The increase in gold was $5,327, in silver 787 ounces, and in copper 299,472 pounds. The increase in the value of the copper was $44,095. The producing gold mines are the Fresno Enterprise, Texas Flat, Madera Consolidated, and Madera County Mining Co. Most of the silver was produced from the ore from the copper mines.

MARIPOSA COUNTY.

Number of mines producing in Mariposa County, Cal., quantity of ore treated or sold in 1905–1913, and total gold, silver, and copper.

Year.	Number of mines producing.	Quantity of ore.	Gold (value).	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	27	88,316	$433,370	6,763	12,541	$439,411
1906	25	64,511	366,394	5,040	.....	369,771
1907	24	51,139	405,498	6,288	7,984	411,245
1908	27	53,972	439,862	8,928	36,757	449,446
1909	34	52,103	396,465	5,247	.....	399,194
1910	38	42,703	317,580	4,377	.....	319,944
1911	32	18,196	172,532	2,623	13,528	175,613
1912	38	21,094	160,541	11,051	300,062	216,847
1913	20	20,671	171,034	12,301	439,168	246,535
Increase (+) or decrease (−) in 1913	−18	−423	+10,493	+1,250	+139,106	+29,688

Mariposa, one of the Mother Lode counties of California, produced a smaller quantity of ore in 1913 than it did in 1912, but had an increased output of gold amounting to $10,493, of silver to 1,250 ounces, and of copper to 139,106 pounds. The increase in total value for the year was $29,688. The deep mines produced 20,671 tons of ore, of which 5,617 tons went to the smelter. The 15,054 tons of ore that went to gold and silver mills yielded $149,971 in gold as bullion, averaging $9.96 per ton, and 1,973 ounces of silver, valued at $1,192, the total gold and silver value of the bullion being $151,163, or an average of $10.04 per ton From this tonnage were also derived 227 tons of concentrates, which yielded $10,953 in gold and 293 ounces of silver valued at $177, a total of $11,130. The concentrates, therefore, yielded $48.25 per ton in gold and $0.78 in silver, an average yield of $49.03 per ton in both gold and silver. The 5,617 tons of ore shipped to the smelter yielded $6,591 in gold, $6,041 in silver value, and 439,168 pounds of copper valued at $68,071, an average value per ton for gold, silver, and copper of $14.36. The siliceous ore yielded on the plates and from the concentrates a total value of $162,293 in gold and silver, an average total value of $10.78 per ton.

Only 20 mines reported production in 1913, as compared with 38 in 1912. Of these, 11 were deep gold mines, 4 copper mines, and 5 small sluicing properties. The placers were at Bagby, Hornitos, Jerseydale, and Kingsley, and their combined output was $3,519 in gold and 33 ounces of silver valued at $20.

At Bagby the Crown Lead is the only producer, and the output was small. The Green Mountain Consolidated Mining Co., at Ben Hur, shipped copper ore to both the Mammoth and the Selby smelters. At Coulterville the producers are the Big Lode, Champney Bros.,

Mountain View, and White Gulch Mining Co. (Virginia mine). At this latter property in the early part of the year the mine was unwatered, shafts and drifts repaired, the hoisting and milling equipment repaired, and a power line created. The improvements were completed and ore was hoisted in August. The Original Mining & Milling Co. is the most productive property in the county. Small percentages of lead and zinc are found in the ore, but are not saved. The Mariposa Commercial & Mining Co., owning the Mariposa, or Fremont grant, worked the Mariposa, Princeton, Pine Tree, and Josephine mines on the leasing or tribute system in 1913. This company has a 5-stamp mill at Mariposa, another 5-stamp mill at Bagby, and a 10-stamp mill at Princeton. The Carrie Todd, owned by the East Lode Development Co., is at Kinsley. Lessees worked the Austin group at Mariposa in a small way in 1913. The Mountain King Mining Co., at Mountain King, which has a 34-stamp mill, was reorganized in 1913. The producing copper mines of the county are the Green Mountain Consolidated, at Ben Hur; Klondike, at Lewis; and Pocahontas, at Lewis. The last named closed down in August, 1913. The Merced Mining Co., at Coulterville, after an idleness of 10 years, installed electric power in 1913 and retimbered the Malvina mine to a depth of 1,000 feet. At the Horseshoe mine, at Hornitos, work was started in the later months of the year preparatory to extensive development in 1914. Several thousand dollars' worth of improvement work was done in the old Mount Gaines mine at Hornitos, but no ore was milled or shipped.

MONO COUNTY.

Number of mines producing in Mono County, Cal., quantity of ore sold or treated in 1905–1913, and total gold, silver, copper, and lead.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	13	23,444	$311,958	15,876	.....	.....	$321,547
1906	7	28,599	338,698	19,628	.....	.....	351,849
1907	8	32,363	383,971	45,147	.....	.....	413,768
1908	11	39,190	413,946	49,310	.....	2,429	440,182
1909	13	48,536	354,909	72,677	3,454	582	393,175
1910	12	24,913	435, 24	17,391	.....	.....	445,115
1911	13	33,469	261,232	66,996	.....	44,289	298,733
1912	15	32,399	377,518	114,800	7,866	24,445	450,518
1913	7	21,953	147,271	38,515	79,323	.....	182,829
Increase (+) or decrease (−) in 1913	− 8	−10,446	−230,247	−76,285	+71,457	−24,445	−267,689

The table shows a decided decrease in 1913 in number of producing mines, in tonnage, and in gold, silver, and lead, the only increase being in copper; and the decrease in total value for the year amounted to $267,689. This is almost entirely accounted for by the greatly decreased output in 1913 of the only large producing mine in the county—the Standard Consolidated, of Bodie, which produced $235,164 less in 1913 than in 1912. The mine was virtually closed down as worked out before the end of 1913.

There were 9,219 tons of crude ore treated at the gold and silver mills, yielding $51,075 in gold and 1,530 ounces of silver, valued at

$924, a total of $51,999 and an average of $5.64 per ton in gold and silver. No concentrates were produced. There were 10,151 tons of old tailings treated which yielded $84,719 in gold and 14,815 ounces of silver, valued at $8,948, a total of $93,667, or an average per ton of $9.23 in gold and silver. The 2,583 tons of ore shipped to smelters yielded $5,978 in gold, 22,104 ounces of silver, valued at $13,351; and 79,323 pounds of copper, valued at $12,295, a total value of $31,624, or an average in all metals of $12.24 per ton.

The only prominent deep mine at Benton is the Blind Spring Hill, although there are a few other properties which made small outputs. The most important district in the county is that of Bodie where the Standard Consolidated and the New Bodie mines are situated. The Standard has been the principal mine of the county for many years, but the operations of the mill and slime plant were suspended October 1, 1913, and since then only a small force of men has been kept in the mine on development work. When the mill and cyanide plant started again, in the spring of 1913 (having been closed the previous winter while explorations for ore were being pushed ahead), there was sufficient ore, together with the tailings in the slimes pond, to run the plant until August. By September the supply of tailings had been exhausted and there remained several hundred tons of ore in narrow veins in the mine, consequently the mine could produce only a small quantity of ore, amounting to about one-third the daily capacity, and the mine was closed. Negotiations are under way for the working or sale of the entire property of the company, including the water-power plant, for generating electricity. The Standard mine has produced since 1879, gold and silver to the value of $16,457,832, from which dividends amounting to $5,274,407 have been paid. During the last month the mine and mill were running in 1913, the recovery was $13.97 per ton, while the cost per ton was $13.39. Both ore and tailings were exhausted. This condition of affairs was anticipated, for the wide veins had been exhausted years ago and the smaller veins only averaged 6 inches in width and many of them could not be profitably mined. The Golden Gate mine, at Colville, was operated only from January to May, 1913. The placer gravel mine, owned by the Casa Diablo Mining Co., at Bishop, was productive during the year.

NEVADA COUNTY.

Number of mines producing in Nevada County, Cal., quantity of ore sold or treated in 1905–1913, and total gold, silver, and copper.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	65	325,266	$3,076,997	41,129	.....	$3,101,839
1906	56	276,602	2,658,420	36,147	.....	2,682,639
1907	52	227,288	2,162,083	25,522	22,111	2,184,010
1908	48	220,067	2,297,963	41,347	.....	2,319,877
1909	56	232,034	2,660,235	47,935	.....	2,685,161
1910	49	250,358	2,533,483	30,566	.....	2,549,989
1911	44	263,062	2,199,147	29,606	.....	2,214,838
1912	44	270,148	2,081,958	37,122	.....	2,104,788
1913	35	276,306	2,918,733	43,944	.....	2,945,275
Increase (+) or decrease (−) in 1913.	−9	+6,158	+836,775	+6,822	.....	+840,487

Notwithstanding the decrease in the number of mines producing in Nevada County in 1913, there was a material increase in the tonnage of ore treated and also in the value of the gold and silver recovered. The production of gold from deep mines increased by $864,016, but the placers decreased by $27,241, thereby making the total increase of gold in the county in 1913 $836,775. This phenomenally large increase in gold production again gives to Nevada County its old position of first in rank in the production of gold, as it exceeded Amador County, the next largest producer, by $16,835. The quantity of ore treated in 1913 in the county was 276,306 short tons. There were 35 productive mines in the county in 1913, of which 27 were deep gold mines and 8 were placers. The 5 drift mines yielded $7,696 in gold and the 3 surface placers $10,179, a total yield of $17,875 in gold from the placers. The deep mines produced 140,329.01 fine ounces of gold, valued at $2,900,858, and 43,828 fine ounces of silver, valued at $26,472, a total value of $2,927,330.

There were 267,761 tons of siliceous ore treated at the gold and silver mills, and 45 tons of siliceous ore were sent to the smelter in 1913. The value of the gold in mill bullion was $2,458,290, or $9.18 per ton, and the silver output from the same source was 26,684 fine ounces, valued at $16,117, or $0.06 per ton. The total value of the gold and silver recovered in the mill bullion was $2,474,407, an average of $9.24 per ton. From the milling ore there was obtained 3,454 tons of concentrates, which carried $402,819 in gold, or an average of $116.62 per ton, and 13,724 fine ounces of silver, valued at $8,289, or an average of $2.40 per ton. The total value of the concentrates was $411,108 in gold and silver, or an average value of $119.02 per ton. From the 267,761 tons of milling ore there was recovered from both bullion and concentrates $2,861,109 in gold, or an average value of $10.69 per ton, and 40,408 fine ounces of silver, valued at $24,406, or an average value of $0.09 per ton. The total value of the gold and silver recovered from bullion and concentrates was $2,885,615, the average being $10.78 per ton in gold and silver. In addition there were 8,500 tons of old tailings treated, which yielded $36,174 in gold, an average of $4.26 per ton, and 3,384 fine ounces of silver, valued at $2,044, or $0.24 per ton, making a total production of gold and silver from old tailings of $38,218, or an average value of $4.50 per ton.

The principal quartz mining district of Nevada County is that of Grass Valley, which includes the mines in both Grass Valley and Nevada City.

The table following shows the production of the Grass Valley district, 1904–1913.

Value of production of Grass Valley and Nevada City quartz mines, Nevada County, Cal., 1904–1913.

Year.	Grass Valley mines.			Nevada City mines.			Total.
	Gold.	Silver.	Total.	Gold.	Silver.	Total.	
1904	$1,738,979	$6,317	$1,745,296	$683,552	$3,400	$686,952	$2,433,248
1905	2,041,447	10,843	2,052,290	440,236	12,531	452,767	2,505,057
1906	2,196,990	16,516	2,213,506	133,031	5,755	138,786	2,352,292
1907	1,744,752	11,200	1,755,952	219,514	5,379	224,893	1,980,845
1908	1,869,176	11,953	1,881,129	192,037	8,552	200,589	2,081,718
1909	2,005,574	16,540	2,022,114	171,604	1,971	173,575	2,195,689
1910	2,113,499	13,101	2,126,600	118,688	1,731	120,419	2,247,019
1911	1,817,091	11,795	1,828,886	174,749	2,329	177,078	2,005,964
1912	1,779,401	18,168	1,797,569	75,890	2,169	78,059	1,875,628
1913	2,591,052	18,308	2,609,360	239,609	7,774	247,383	2,856,743
Increase (+) or decrease (−) 1913	+811,651	+140	+811,791	+163,719	+5,605	+169,324	+981,115

Both Grass Valley and Nevada City increased the value of their output for 1913—Grass Valley by $811,791 and Nevada City by $169,324. The increase in yield of the entire district amounted to $981,115. The total ore treated in the district was 252,607 tons, of which 214,726 tons came from Grass Valley mines and 37,881 from those of Nevada City. The Grass Valley quartz mines produced 77.71 per cent of the tonnage of the whole county and the mines at Nevada City 13.71 per cent, the district of Grass Valley, therefore, produced 91.42 per cent of the ores milled in Nevada County in 1913. The Grass Valley deep mines produced $2,591,052, or 89.32 per cent of the quartz gold obtained in Nevada County in 1913, and 69.16 per cent of the quartz silver, or 89.14 per cent of the total value derived from quartz ores. Nevada City deep mines produced $239,609, or 8.26 per cent of the quartz gold obtained in Nevada County, and 29.37 per cent of the quartz silver, or 8.45 per cent of the total value derived from quartz ores of the county during 1913.

The Grass Valley district (including Grass Valley and Nevada City mines) produced 97.58 per cent of the quartz gold and 98.53 per cent of the quartz silver and 97.59 per cent of the total value derived from quartz mining operations in Nevada County in 1913. The producing mining companies at Grass Valley in 1913 were the Ben Franklin, Brunswick Consolidated, Central Consolidated, Empire Mines, Golden Gate Consolidated, Idaho-Maryland, North Star Mines, and Union Hill Consolidated. The Ben Franklin ships its ore to a custom mill. The Brunswick Consolidated has a 20-stamp amalgamation and concentration mill. The 1913 development work consisted of 774 feet of drifting, 535 of upraising, 300 feet of crosscutting, and 474 feet of shaft sinking. There is one incline shaft 1,250 feet deep and a vertical shaft 874 feet deep. The Empire mines now include that property and the Pennsylvania mine, known as "The Empire mines, Pennsylvania shaft." There are 2 mills, one of 20 and the other of 40 stamps. Recovery is made by inside and outside amalgamation in mill, the tailings being sent direct to the cyanide plant. The concentrates are reground in a tube mill and then sent to the cyanide plant. The Golden Gate Consolidated is equipped with a 10-stamp mill. The Idaho-Maryland Development Co. has a 20-stamp mill; the

deepest workings in this mine are 2,187 feet deep. The North Star Mines, the most productive deep gold mine in the State, is operated through a shaft 5,850 feet deep on the incline or 2,200 feet in vertical depth. There are 2 mills of 40 stamps each, with concentrating and cyaniding plants attached. All the ore delivered at the stamp mills is subsequently cyanided either as concentrates or tailings, except about 30 tons a month at each plant allowed for loss by leakage and slopping over. As this is a typical California quartz mine, some extracts from the annual report for 1913 will be of interest to mining men:

During the year the gross production of the North Star mine was $1,200,096.42, obtained at a cost for current operation of $501,070.92 and for development work of $50,926.87, or a total outlay for operation and development of $551,997.79, leaving a profit of $648,098.63. Expenditures during the year on account of property purchase and improvement amounted to $13,361.80, leaving a balance of $634,796.83. Interest and dividends on invested funds amounted to $35,756.90, increasing the total net earnings for the year, before deduction of allowance for depreciation and of expenses on account of the Champion mines, to the sum of $670,553.73. Dividends amounting to $300,000, or 12 per cent on the capital stock, were paid during the year, bringing the total dividend payments of the North Star Mines Co. up to 143 per cent.

The above stated product was chiefly derived from stopes above the 3,400, 3,700, and 4,000-foot levels, and was obtained from 112,110 tons of rock mined and delivered to the mills, of which 6,020 tons were sorted out as waste, leaving 106,090 tons of ore crushed, with an average yield of $11.312 per ton, at an average cost of $4.723 per ton for operating and $0.480 per ton for development expenses, making an aggregate cost of $5.203 per ton crushed ($4.903 per ton mined), and leaving a realized profit of $6.109 per ton crushed.

The stopes during the year were in condition for advantageous operation and the yield per ton crushed in 1913 was $1.049 more than in 1912, while the cost of operation and development was reduced from $5.524 to $5.203 per ton.

Of the total production of the year, 78.18 per cent was obtained in the mills by amalgamation; and 21.82 per cent was recovered by the cyanide process, including the value of 1,629 tons of concentrates treated. About the beginning of December, the large tube mill in the Central cyanide plant, which had hitherto reground all the concentrates, was made over into two smaller tube mills, one of which was installed in the North Star and one in the Central mill, after which time the value of the concentrates is not, and will not be, shown separately but included partly with the fine gold obtained by amalgamation and partly with the gold recovered from the mill tailings by cyanide treatment. The assay value of the tailings from the cyanide plants was 28 cents a ton, indicating a total loss in treatment of $30,000, or about 2½ per cent of the total contained value of the ore.

Development work in the North Star mine, on and above the present bottom, consisted in the further extension of the 5,000-foot and 5,300-foot drifts and the connection by raises of various levels. The drifts reached what appears to be the eastward extremity of the ore-bodies and were stopped. The raises have further developed, and confirmed the expectation of an ore supply, of about the average quality, on and above the 5,300-foot level, calculated to last for several years to come.

Costs at the North Star in 1913 were as follows: Development, 48 cents; mining, $2.895; milling, 47.6 cents; concentrating, 11.5 cents; cyaniding, 45.2 cents; bullion, 3.1 cents; miscellaneous, 25.3 cents; New York office, 15.4 cents; taxes, 26.7 cents; and accident and benefit, 10.4 cents.

The financial statement of this company from May, 1884, to the end of 1913 shows that from the North Star, Stockbridge, New York Hill, Gold Hill, and Cincinnati Hill claims, there have been worked and milled 1,141,284 tons of ore, which yielded $13.358 per ton, or a total of $15,245,188. The total operating and development expenses have been $9,559,202, so that the profit has been $5,685,986. The dividends have been $4,087,040. In accordance with the new income tax, a depreciation of the property amounting to $60,005, or 5 per cent of the yield of $1,200,096, has been written off for 1913, while depreciation on equipment was at the rate of 7½ per cent.

In Nevada City the California-Montana Mining Co. made a small output, as did the Grizzly Ridge and the Pittsburg-Gold Flat. The Champion mines are now owned by the North Star Mines Co. of Grass Valley. On this property are situated several incline shafts, the largest one being 2,400 feet, and about 6,000 feet of drifts, raises, and crosscuts were driven during the development work in 1913. The Champion 40-stamp mill was run during the year to about half capacity and in an experimental way, with the result that 26,850 tons of rock were crushed, yielding $124,178.97. The operating and development expenses for the year amounted to $241,338.08, exceeding the production by $117,159.11. The sum of $27,987.19 was expended for improvements and the balance paid on account of the purchase of the property amounted to $217,822.81, bringing the total expenditure for the year to the sum of $487,148.08, against which may be set the before mentioned production of $124,178.97. At the end of 1913 the investment in the Champion mines, including purchase money, equipment, and development, had called for an outlay of $858,100.73, with a production up to that time of $154,528.57. It is expected that a better showing will be made by the Champion mines in 1914. Ore of a fair quality is now being produced from various stopes, and changes already made in the method of treatment and economies resulting from the method for underground work should result in higher extraction values and lower costs.

A few thousand dollars in gold from pocket ore was taken on a lease from the old Numitor mine near the border of Placer County. The Washington mine at Gaston was also a producer. The Birchville, at Graniteville, ran its mill about three months only, and the Republic at the same place milled ore for two months. The lessee of the Zeibright mine obtained considerable gold from ore reduced in the 10-stamp mill on the property. The Consolidated St. Gothard at North Columbia, and the Black Bear at Rough and Ready, made nominal outputs only.

The placer mines of Nevada County are now few in number and are drift or sluicing mines. The Liberty Hill, Birdseye Creek, and Nevada Mining Co. are in the You Bet section; the Blue Danube and Fisher are at French Corral, and the Remington Hill is at Lowell Hill.

There are a number of nonproductive mines in the county, but development work is continued. The Sultana Mining Co., of Grass Valley, stopped work in the Sultana and Prescott shafts and renewed operation of the Orleans shaft. Considerable prospecting work was done on the Bellefontaine, in Willow Valley district. The Cold Springs and Channel mines, of Nevada City, now form the Victory Mines Co. (Ltd.), organized under the laws of Hawaii, with head office at Honolulu. At the Arkansaw Traveler, Spenceville, development work was done throughout the year and considerable copper and gold ore was extracted but not treated. A reduction plant is to be installed. The Eagle Bird mine, at Washington, is under option to a company which is equipping the prospect. The water flumes have been rebuilt and the house and mill, destroyed by fire, are to be reconstructed. The Ocean Star mine, at Washington, is in course of development.

PLACER COUNTY.

In 1913 Placer County produced gold and silver valued at $223,757, against $372,174 in 1912. There was also a nominal output of copper and silver. The total gold yield in 1913 was 10,680.47 fine ounces, valued at $220,785, and the silver was 4,921 ounces, valued at $2,972. The decrease in gold output for 1913, as compared with 1912, was $146,598. The deep mines produced from 17,683 tons of ore, 4,052.42 fine ounces of gold, valued at $83,771; 4,348 ounces of silver, valued at $2,626; 374 pounds of copper, valued at $58; and 682 pounds of lead, valued at $30. The total values recovered from the deep mines was $86,485. The placer mine yield was 6,628.05 fine ounces of gold, valued at $137,014, and 573 ounces of silver, valued at $346. Of the placer gold $78,839 was derived from 3 dredges; $44,826 from 15 drift mines; and $13,349 from 8 surface placers. The placer gold yield of the county was $107,606 less in 1913 than in 1912. The deep mine decrease in gold yield was $38,992. There were 26 producing placers in the county in 1913, and 13 deep mines, a total of 39, as compared with 65 in 1912. Placer continues to be the leading drift mining county of the State, but it only slightly exceeds Butte County in gold output from this source.

Of the deep mines in the county the Jubilee, near Auburn, had its shaft put down 200 feet in 1913. The Dewey, at Butcher Ranch, was worked in a small way, the richest ore being crushed in a heavy mortar and the remainder sent to a mill. The old Dairy Farm mine, operated under lease by the Vantrent Mining Co., was the most productive of the deep mines of the county. It is being developed through a "glory hole" and the ore is ground in a Chile and tube mills. A 100-ton cyanide plant was completed in June, 1913. The Big Bursar, another good producer, at Newcastle, was shut down at the end of May, 1913. The Eureka, the Soudan, and a few other small quartz mines are operating at Newcastle and a few at Rocklin. The Helester is being worked near Towle.

Of the placer mines in the county three were worked by dredges, the Gaylord, near Auburn, working on bars in American River; the Cache Rock, near Forest Hill, since out of business; and the Beaver Gold Dredge Co., near Loomis. Most of the other placer producers in the county are drift mines. The principal placers are the Haub, at Blue Canyon; Union, at Dutch Flat; Paragon and Red Point, at Forest Hill; Canyon Creek, at Gold Run; Carrie, McGeachin, and Penn Valley, at Iowa Hill; Lincoln, Frankmont, and Pacific Slab, at Last Chance; Ranch, near Lincoln; F. & F., Terry, Laird & Quinn, and Pendleton, at Loomis; and Blue Eyes, Bogus Thunder, Devil's Gate and Sunset, at Towle.

Of the nonproducing mines of the county, the El Dorado & Placer Counties Mining & Power Co. has acquired dredging ground on the Middle Fork of American River and since the close of the year has installed a dredge. The Auburn Mining Co. has been engaged in running a long bedrock tunnel on the east side of Shirttail Canyon, near Forest Hill, and expects to reach the gravel channel in 1914. Some development work has been done on the old Mayflower drift mine, Forest Hill. The White Oak, Forest Hill, continued running bedrock tunnel. The Pendleton, at Last Chance, developed its ore

bodies, but did no milling. The Big Gun mine, Michigan Bluff, was preparing to dredge what was formerly hydraulic ground. The Herman Property Syndicate, at Westville, remained idle pending installation of electric power. Many of the former larger deep and drift mines producing in the county were idle during 1913.

PLUMAS COUNTY.

Number of mines producing in Plumas County, Cal., quantity of ore sold or treated in 1905–1913, and total gold, silver, copper, and lead.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	
1905	88	31,455	$269,992	1,847	1,066	.....	$271,274
1906	78	21,040	229,350	1,575	.....	.....	230,405
1907	80	23,907	219,355	1,436	.....	.....	220,303
1908	51	29,537	254,737	6,717	.....	.....	258,297
1909	54	27,795	157,491	1,130	.....	.....	158,078
1910	46	41,681	187,207	1,923	.....	1,114	188,294
1911	53	47,470	228,785	2,123	1,328	.....	230,076
1912	67	27,398	193,237	1,556	16,381	5,837	197,160
1913	39	35,354	138,368	1,167	22,677	5,432	142,827
Increase (+) or decrease (−) in 1913	−28	+7,956	−54,869	−389	+6,296	−405	−54,333

The total yield from the mines in Plumas County in 1913 was $54,333 less than in 1912. Notwithstanding the increase in tonnage, there was a decrease in gold, amounting to $54,869; in silver of 389 ounces; and in lead of 405 pounds. There was a slight increase of $812 in the value of the copper output, which reduced the total shrinkage in value of output for the year. The gold production was 6,693.56 fine ounces, valued at $138,368; the silver value was $705, the copper value $3,515, and the lead value $239. There were 35,299 tons of siliceous ore treated at the mills, which yielded $78,804 in gold and 615 fine ounces of silver, valued at $371. The crude ore treated at gold and silver mills yielded 72 tons of concentrates, which produced $2,071 in gold and 147 fine ounces of silver, valued at $89. The placer mines yielded 2,736.82 fine ounces of gold, valued at $56,575, and 263 fine ounces of silver, valued at $159. There were 26 producing placers and 13 producing deep mines. Of the former, 7 were hydraulic mines, yielding $16,775 in gold; 7 were drift mines, yielding $31,139 in gold; and 12 were sluicing mines, yielding $8,661 in gold. There was a decrease of 1 hydraulic mine, of 7 drift mines, and of 11 sluicing mines in 1913, as compared with 1912. There was a slight decrease in the gold production from the hydraulic mines and also from the sluicing mines, but the drift mines showed the marked decrease of $25,792.

Of the deep mines in Plumas County, the Jamison, at Johnsville, is the most productive, and the Droege, at Greenville, comes next in rank. The Jamison is developed by a vertical shaft 150 feet deep, and by 1,800 feet of drain tunnels, 3,764 feet of crosscut tunnels, and 8,691 feet of drift tunnels. Owing to a shortage of water for power the mine and mill were only run about 175 days in 1913. The Droege was also idle a month for the same reason. Other deep mine pro-

ducers are the Bullion, at Clio; Five Bears and Gruss at Genesee; Plumas-Eureka, at Johnsville; Oro Fino, Crescent Hill, and Hungarian Hill, at Quincy; Seneca, at Seneca; and Mohawk group, at Vinton.

The producing placer mines are the Consolidated Placer and Indian Hill, at Belden; the New York and the Old Rutherford, at Meadow Valley; the Pactolian which did but little in 1913, at Genesee; the General Harrison and West Elizabeth, at Johnsville. The mines at La Porte are the Angora Canyon Creek, Consolidated Alturas (sluicing old tailings), and Bellevue, the latter a drift mine and the largest producing gravel mine in the county. There are a few small placers at Lumpkin. The Gold Mountain hydraulicked in a small way at Meadow Valley, and the Willow Creek did sluicing work at Nelson Point. At Prattville the Sunnyside drift mine was in operation. The placer mines at Quincy are the Pioneer, Bessie, Crown Point, Oversight, and Santa Cruz. Those at Seneca are the Scott and the Yankee Bar.

Of the nonproductive mines the Caldwell, at Meadow Valley, was under development the entire year. The Channel Peak, at the same place, has been worked steadily for nine years without production while cutting a tunnel to reach an old river channel. The gravel was reached in October, 1913, and then the mine was closed down for a time. At the Idaho Thunder Mountain, at Meadow Valley, retimbering and repairing old tunnels was carried on. The Indian, at Twain, was developing its drift mining property the entire year. The Glacier and the Dominion, at Greenville, which are drift mines with bedrock tunnels, respectively, 1,600 and 800 feet long, continued driving tunnels throughout the year. The Fortuna and the Grass Valley mines, at La Porte, are running tunnels to reach gravel. The Engels Copper Mining Co., at Taylorsville, built a furnace for reducing its ores, but was not allowed to use it in the forest reserve. The company, therefore, built a concentrating mill (flotation process) and will have it in operation in 1914.

RIVERSIDE AND LOS ANGELES COUNTIES.

In Riverside County there were four producing deep mines and two in Los Angeles County, there being no placers in either. In Riverside County there were only 780 tons of ore treated, yielding 604.74 fine ounces of gold, valued at $12,501, and 172 ounces of silver, valued at $104, a total value of $12,605. The Desert Queen, at Banning, was under lease part of the year. The Poplin, at Blythe Junction, was a small producer, as was the Justice, at Perris. The only mine of any note now producing in the county is the New El Dorado, at Indio, where a new 5-stamp mill was completed in 1913 and also a 10-mile pipe line. The water supply is limited and is settled in tanks and pumped back for reuse. Before the completion of the reduction works the ore was hauled 4 miles to the Hexahedron mill. Of the new producers, the Priest-Ranger Co. shut down in March, 1913.

In Los Angeles County the two mines operating produced 185 tons of ore, which yielded 112.33 ounces of gold, valued at $2,322, and 45 ounces of silver, valued at $27, a total of $2,349.

SACRAMENTO COUNTY.

Number of mines producing in Sacramento County, Cal., quantity of ore sold or treated, 1905–1913, total gold and silver.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Total value.
		Short tons.		*Fine ounces.*	
1905	8	.....	$650,624	2,745	$652,282
1906	8	.....	986,624	5,433	990,264
1907	12	.....	790,973	3,082	793,007
1908	20	.....	1,166,055	3,058	1,167,676
1909	12	.....	1,669,814	5,492	1,672,670
1910	17	150	1,396,874	8,530	1,401,480
1911	11	.....	1,812,826	5,749	1,815,873
1912	15	.....	1,712,587	5,762	1,716,131
1913	15	.....	2,503,633	5,639	2,507,039
Increase (+) or decrease (−) in 1913	00	.....	+791,046	−123	+790,908

Sacramento County in 1913 made, next to Nevada County, the largest increase in value of gold output in the State, amounting to $791,046, from $1,712,587 in 1912 to $2,503,633 in 1913. This very material increase brought Sacramento into third place in rank of the gold-producing counties of California, its output being exceeded only by that of Nevada and Amador counties. Sacramento is now the leading producer of placer gold in California, exceeding Yuba and Butte counties, each of which have held this position in turn during recent years. This large gold yield is almost entirely due to the work of the dredges in the Folsom field, a district pretty thoroughly worked by the early day miners with the systems then in vogue and for many years virtually abandoned except for operations on a small scale, until the advent of the dredges. There were 12 dredges working in the field in 1913, as compared with 11 in 1912 and with 10 in 1911. Ten of these were owned by the Natomas Consolidated of California, 1 by the Union Dredging Co., and 1 by the Ashburton Mining Co. Two of the machines of the Natomas were remodeled or rebuilt so as to be operated in 1913, and another, the largest built, was worked only a few months in 1912 but continuously during 1913. In the report on California Mineral Resources for 1912 a résumé of the operations of this company was given. Aside from the dredge operations, the Embach Mining Co. and Wright & Donnelly have productive drift mines, and there are a few small placers being worked.

The following table shows the dredge gold output from the Folsom field for several years, with the annual decrease or increase, and total:

Mine production of gold of Folsom dredging district, California, 1902–1913, with increase (+)or decrease (−), by years.

Year.	Production.	Increase (+) or decrease (−).	Year.	Production.	Increase (+) or decrease (−).
1902	$155,191	.....	1909	$1,534,136	+$424,940
1903	102,097	−$53,097	1910	1,369,594	− 164,542
1904	348,990	+246,893	1911	1,805,071	+ 435,477
1905	569,124	+220,134	1912	1,672,797	− 132,272
1906	921,300	+352,176	1913	2,498,603	+ 825,806
1907	649,511	−271,789			
1908	1,109,196	+459,685	Total	12,735,613	.....

SAN BERNARDINO COUNTY.

Number of mines producing in San Bernardino County, Cal., quantity of ore sold or treated 1905–1913, and total gold, silver, copper, lead, and zinc.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	15	34,039	$434,461	66,969	52,603	.....	.....	$483,116
1906	15	37,271	354,830	50,396	514,031	30,700	.....	489,552
1907	27	26,158	158,676	123,241	590,649	9,020	.....	358,623
1908	49	25,182	180,511	67,366	201,993	117,024	.....	247,793
1909	35	4,449	40,071	24,173	148,312	11,366	.....	72,410
1910	25	7,102	55,093	18,822	5,992	1,545	.....	66,088
1911	55	18,190	127,367	67,061	679,984	23,466	182,316	259,355
1912	29	44,722	293,900	81,238	1,890,008	96,439	.....	660,053
1913	54	40,513	356,524	73,531	484,568	237,480	.....	486,494
Increase (+) or decrease (−) in 1913	+25	−4,209	+62,624	−7,707	−1,405,440	+141,041	.....	−173,559

Notwithstanding the increase of the number of producing mines in San Bernardino County from 29 in 1912 to 54 in 1913, there was a decrease in the quantity of ore treated. This decrease in tonnage is responsible for the decrease of $5,549 in the value of the silver output and of $236,744 in the value of the copper production of the county. The gold yield increased by $62,624 and the lead production made a material increase of $6,110 in value. The silver output of the county in 1913 was valued at $44,413, the copper at $75,108, and the lead at $10,449. Twenty-six gold mines, 16 copper mines, 3 silver mines, 8 silver-lead and lead mines, and 1 placer mine reported production in 1913. There were 39,782 tons of siliceous ore sold or treated in the county, 327 tons of copper ore, and 404 tons of lead ore, a total of 40,513 tons. Of this total tonnage, 12,639 tons were treated at gold and silver mills, yielding $157,414 in gold, and 3,891 fine ounces of silver, valued at $2,350. No concentrates were produced from this ore. There were 20,906 tons of crude ore sent to smelter, yielding $178,041 in gold and 68,417 fine ounces of silver, valued at $41,324. In addition to this, there were 6,968 tons of old tailings treated, yielding $20,259 in gold and 1,218 fine ounces of silver, valued at $736. The copper ores yielded 147.25 fine ounces of gold and 18,571 fine ounces of silver. The lead ores produced 205.30 fine ounces of gold and 6,579 fine ounces of silver. Ores of the silver and silver-lead mines are included in the siliceous ore milled or smelted.

The most important productive mine in the county in 1913 was, as in 1912, that of the Pacific Mines Corporation, at Ludlow (Stagg post office). The contract expired and ore shipments to Arizona and Salt Lake smelters ceased on September 1, 1913. Development work only has since been done on the properties. The Southwestern Lead Co., of Bagdad, closed its mine in September, 1913, after making a small output for the year. The Bagdad-Chase Co., of Barstow, only operated after May 1. It is equipped with a cyanide plant of 1,000 tons capacity, working on tailings. The Copper Buttes and Calenode group and the Paradise Mountain Mining Co. are also producers at

Barstow. The total output of this camp for the year was valued at $73,496, principally gold. At Barnwell are located the Gold Bronze, Barnett Co., and Sagamore mines, with a combined output in 1913 of $6,854. The mines at Calzona are the Jack Knife group, Parker, O. K., Sanborn, Tuscarora, and Watch Me, with a combined output valued at $26,746. The mines at Cima are the Death Valley, Arcalvada, Henry, and Gibson, which made a combined yield of $5,847. Some little silver was mined by lessees in the old Waterloo ground at Daggett. At Dale the United Greenwater Copper Mines produced considerable gold and silver from the Supply claim. The ore is treated by dry crushing and direct cyanidation by percolation. The plant has a capacity of 100 tons daily. Some 3,300 feet of development work was done in the mine in 1913. The Lucy Gray Co. made a small output at Desert. At Goffs are located the Louisiana-California Mining Co., Belle McGilroy, Pilot, and Contention, and a few other small producers. The Big Chief mine at Hart was only in operation about one-third of the time in 1913 and was closed in November owing to shortage of water. The Carbonate Mining Co. is the only producer of importance at Halleck, and a few small mines are producing at Kelso, Kramer, Leastalk, Needles, and Silver Lake. At Victorville are the Gold Peak and the West End; and at Vidal are the D. & W. Mining Co., the Whipple Mountain Mining Co., and a few other small properties. The Coolgardie Mining Co. recovered some gold from an old river bed, but the property was not operated to any extent.

Among the nonproducing mines some development work was done during the year in the old Calico mine at Daggett. Considerable development work was also done at the World's Desire, at Kelso, and also on the Oro Belle, at Hart. The Roosevelt, at Ludlow, has been absorbed by the Pacific Mines Corporation.

SHASTA COUNTY.

Number of mines producing in Shasta County, Cal., quantity of ore sold or treated, 1905–1913, and total gold, silver, copper, lead, and zinc.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	38	214,036	$706,738	270,530	10,830,865	.....	.....	$2,559,75
1906	30	327,482	819,144	648,482	22,477,304	.....	.....	5,591,74
1907	35	342,856	791,997	560,926	25,457,417	.....	.....	5,853,69
1908	39	556,922	1,131,832	976,596	33,852,842	.....	.....	6,118,00
1909	34	854,256	1,600,489	1,414,346	50,013,511	.....	.....	8,837,70
1910	46	696,333	1,533,728	1,201,676	40,397,284	196	.....	7,313,09
1911	63	520,795	1,133,476	730,171	29,618,032	.....	.....	5,222,98
1912	39	415,116	928,243	691,257	24,618,550	.....	.....	5,415,42
1913	41	477,746	1,208,870	741,773	27,044,297	19,295	93,914	5,854,87
Increase (+) or decrease (−) in 1913	+2	+62,630	+280,627	+50,516	+2,425,747	+19,295	+93,914	+439,44

Shasta County is the most productive in metallic output in the State, a position it has held for some years, largely on account of its copper mining industry. In 1913 the total value of the metals produced in the county was $5,854,875, or $2,909,600 more than in

Nevada, the next county in rank of total production. In 1913 Shasta increased the total value of its metallic output by $439,449. In fact it increased in every respect. There were 2 more mines operated in 1913 than in 1912; 62,630 more tons of ore were treated; the gold yield was $280,627 larger; the silver increased by 50,516 ounces; the copper by 2,425,747 pounds; the lead by 19,295 pounds; and the zinc by 93,914 pounds. This is rather remarkable, in view of the fact that while there were formerly 4 smelting plants in operation in the county, there was only 1 in 1913.

The total number of deep mines from which production was reported was 32, as against 30 in 1912. Of these, 25 were gold mines, 5 copper mines, 1 silver-lead, and 1 zinc. The output of 477,746 tons of ore was made up of 92,273 tons of siliceous ore, 385,343 tons of copper ore, 1 ton of silver-lead ore, and 129 tons of zinc ore.

The placer mines of the county in 1913 yielded 3,105.38 fine ounces of gold, valued at $64,194. This production came from 2 dredges, 1 drift mine, and 6 surface placers.

The gold obtained from the deep mines was 55,373.70 fine ounces, valued at $1,144,676, and the silver 741,028 fine ounces, valued at $447,581. The gold derived from siliceous ore amounted to 43,100.24 fine ounces, valued at $890,961, and that from copper ore 12,271.48 ounces, valued at $253,669. The silver production from siliceous ore was 35,295 ounces, valued at $21,318; from copper ore 705,634 ounces, valued at $426,203; and from lead ore 99 ounces. The siliceous ore, therefore, yielded $912,279 in gold and silver, and the copper ore yielded $679,872 in gold and silver, a total (including nominal quantities from the lead ore) of $1,592,257 in gold and silver from the deep mines.

The gold and silver mills in Shasta County in 1913 treated 48,903 tons of ore, which yielded in gold bullion $571,238, an average of $11.68 per ton, and 4,782 fine ounces of silver, valued at $2,888, an average value of $0.06. The total recovery of mill bullion was valued at $574,126, or an average value in gold and silver of $11.74 per ton. This ore produced 408 tons of concentrates, with a gold value of $35,207, and 695 fine ounces of silver, valued at $420, a total value of concentrates of $35,627. The average value per ton of the concentrates was $86.29 in gold and $1.03 in silver, a total average value of $87.32 per ton. The gold value of the ore treated at gold and silver mills was $606,445, an average of $12.40 per ton; the silver value was $3,308, or $0.07 per ton; and the total gold and silver value from mill bullion and from concentrates was $609,753, or an average recovery of $12.47 per ton.

The crude ore sent to smelters, amounting to 428,786 tons, produced (in addition to the copper) $538,151 in gold, an average of $1.25 per ton, and 735,389 fine ounces of silver, valued at $444,175, or $1.04 per ton. The total value of gold and silver recovered from ore sent to smelters was $982,326, or an average value of $2.29 per ton.

There were treated in the county 57 tons of old tailings in 1913, which yielded $80 in gold and 162 fine ounces of silver, valued at $98, or a total value of $178.

Only one large smelting plant for copper ores continued operations in Shasta County in 1913, the other three still remaining idle owing to smelter fume litigation. The Mammoth Copper Mining Co. still

continues its regular blast furnace practice, aided by an extensive bag house to eliminate fumes. The blister copper produced is shipped to the United States Metals Refining Co., at Chrome, N. J. The smelting plant was kept in continuous operation during the year 1913, and the mine output was the largest in the State, exceeding in value the yield of any single county. The Balaklala Consolidated Copper Co. at Coram, whose smelter was "closed down by the farmers," got out considerable ore during the year, most of which was sold to the Mammoth Copper Co., but some was also shipped to the Mason Valley smelter in Nevada. The Siskiyou and Nightingale are the only deep-mine producers at Bayles. The Original Quartz Hill at Buckeye, is under lease to the Mammoth Copper Co., and its ores are shipped to the smelter at Kennett for reduction. The Ruby Pearl is a small producer at Castella. At French Gulch are the Denver Lode, El Dorado, Eureka group, Empire, Hazel, Highland, Summit Gulch, Washington, and the Western Exploitation Co. Of these the Hazel Mining Co., operating the Gladstone mine, is the most important; it had a gold output larger than any other mine in the county. This mine is opened by an adit 3,300 feet long to an underground vertical shaft 1,150 feet deep. During 1913, 500 feet of shaft was retimbered, and the eleventh level was run 1,000 feet. Drifts and raises to the extent of 1,500 feet were also cut. A new hoist station was made and an underground 375 horsepower electric hoist was installed. The mine is equipped with a 30-stamp mill. The combined output of all the mines at French Gulch was $314,756, the values being mainly gold. At Ingot are the Donkey and Moonlight mines. At Kennett are the Exchange, Friday-Lowden Copper Co., Mammoth Copper Co., Virginia Mining Co., and Pittsburg & Mount Shasta Co. Their combined output is by far larger than that of any other mining district or camp in the State, aggregating nearly $4,000,000 for 1913. The Mountain Copper Co. owns the Iron Mountain, No. 8, and Hornet mines in one group near Kennett. There is now no reduction plant at the mine, but the ore is shipped by rail 250 miles to the smelter plant near Martinez on San Francisco Bay. The sulphide ore is roasted to manufacture sulphuric acid, and the calcined ore, with suitable mixture of other ores, is smelted in reverberatories. The copper matte carrying the gold and silver is shipped to the Baltimore Copper Smelting & Rolling Co., Baltimore, Md. Some copper cement is produced from the mine water by precipitation on scrap iron. The Midas mine, one of the large producers of the county, in Harrison Gulch district (Knob post office), has a 20-stamp mill, and during the year constructed a new cyanide plant to be put in operation in 1914. The Victor Power & Mining Co. at the same place has its mine operated by a 400-foot incline shaft and has a 3 Nissen stamp amalgamation and concentration mill. The Parker Metal Mining Co. has been for 10 years past prospecting and working the Silver King lode, 4 miles from Redding, and has hoisted some ore of shipping grade. At the old camp of Shasta are the Shasta Monarch, Happy Jack, and Black Hawk mines. The Evening Star, at Whitehouse, is quite a large producer, shipping its ore to the smelter for reduction. The Bully Cave Co., at Winthrop, produced some copper ore in 1913. The Bully Hill Copper Co. remained closed down but is still experimenting with its zinc ores. Of the placer mines of Shasta County, the Shasta Dredging Co.'s property, at Larkin, is the only one of much impor-

tance. The Yosemite dredge is also operating near Redding. Other placers are the Rice and Slattery & Welch, at French Gulch; Big Bowlder, at Lamoine; and Lost Channel, at Igo. There are a few small productive placers also, at Bayles, Gas Point, and Taylor.

Among the nonproducing mines the Afterthought Copper Co., at Ingot, made satisfactory experiments at the smelter for saving the zinc, in addition to the copper, silver, and gold. Considerable development work was done at the Pittsburg & Mount Shasta property, at Kennett. On the Whiskey Creek group, at Stella, development work is being continued but no ore has been marketed. The Evening Star, at Whitehouse, remained closed during the year owing to "smelter and farmer" troubles.

SIERRA COUNTY.

The total metal production of Sierra County in 1913 was valued at $1,011,136, as compared with $735,765 in 1912, an increase of $275,371. Of the total increase, $273,585 was in gold, $1,528 was in silver, $75 in copper, and $183 in lead. The yield of the county in 1913 was 48,692.97 fine ounces of gold, valued at $1,006,573; 7,127 fine ounces of silver, valued at $4,305; 484 pounds of copper, valued at $75; and 4,159 pounds of lead, valued at $183. There were 74,656 tons of siliceous ore treated in 1913, yielding 45,033.50 fine ounces of gold, valued at $930,925, and 6,738 fine ounces of silver, valued at $4,070, which, with the small copper and lead values, made a total value of $935,253 from the deep mines. The gold output from the placers was 3,659.47 fine ounces, valued at $75,648, and 389 fine ounces of silver, valued at $235, a total of $75,883. Of this placer gold, $47,471 came from 6 hydraulic mines, $21,644 from 11 drift mines, and $6,533 from 7 surface or sluicing mines. There were 41 producing mines in 1913, 17 of which were deep gold mines. The deep mines in 1913 produced $855,277 in gold more than the placers, at the same time increasing their gold yield in 1913 by $314,440, and thus showing that they were the dominant factor in the production of gold in the county. At Alleghany, the principal producing center of the county, the quartz mines produced in gold $668,037 from 41,641 tons of ore, as compared with $293,561 from 18,389 tons of ore in 1912. From the deep mines of this camp alone, therefore, there was an increased gold yield amounting to $374,476 in 1913, as compared with 1912. At this camp are the Croesus, Sixteen to One, Thunderbolt, Tightner Mines Co., and Gold Canyon. The Sixteen to One is developed by a main tunnel 1,200 feet long and a winze. The ore is crushed in a Chipmunk crusher and run through a Berdan amalgamating pan. During the year electric power was installed at the mine and two compressors, underground electric hoist, pan, crusher, blower, and four motors were added to the equipment. At the Tightner 4,229 feet of development work was done during 1913, 10 stamps were added to the old 10-stamp mill, and 3 Wilfley concentrators were put in. The concentrates recovered are stored for the present. This mine is by far the largest producer in the county and is fast becoming one of the big mines of the State. At the Gold Canyon mine considerable development work was done during the year. The deep mines at Downieville are the Black Warrior, Oxford, Sierra & El Oro, and Willoughby. The Four

Hills Mining Co. was the only producer at Johnsville. Next in rank to the Tightner as a gold producer is the Sierra-Alaska Mining Co., at Pike. At Sierra City the productive deep mines are the Buffalo, Cleveland, Sacred Mound, Swastika, and Sierra Buttes, the last being the most important. It is one of the oldest of the quartz mines of the State and is equipped with a 20-stamp mill and a 100-ton cyanide plant.

Of the placers the Brandy City hydraulic at Brandy City is the most important producer. The mine was able to work 133 days of 24 hours (3,192 hours) in 1913. The Depot Hill hydraulic mine and the Indian River (Orient) drift mine are at Camptonville. The mines at Downieville are mainly worked on the drifting system. These are the Best Chance, Dragon Fly, Excelsior, Wideawake, Monte Cristo (the largest producer), and Soldier Boy, with a combined gold output of $21,982. At Forest are the Bull Moose and Columbia Channel, and a few smaller drift mines. The Morristown hydraulic and Quartz Hill sluice are small properties at La Porte. The Neocene is hydraulicking at Scales. At Sierra City are the Big Canyon, Ladies Canyon, and Pike; the Caledonia is at St. Louis, and the Bruckerman and Miners Home are at Table Rock.

SISKIYOU COUNTY.

In 1913 Siskiyou County produced 8,713.54 fine ounces of gold, valued at $180,125, and 2,034 ounces of silver, valued at $1,228, a total of $181,353, and a decrease of $251,668 as compared with $433,021 in 1912. There were 16 deep mines producing, as compared with 37 in 1912, and these produced 3,508 tons of ore, yielding 2,392.53 fine ounces of gold, valued at $49,458, and 954 ounces of silver, valued at $576, a total of $50,034, as compared with $192,058 in 1912. The 58 producing placers yielded 6,321.01 fine ounces of gold, valued at $130,667, and 1,080 ounces of silver, valued at $652, a total of $131,319, as compared with $240,963 in 1912. The placers thus yielded $81,285 more in gold and silver than the deep mines did. The number of producing mines (74) in Siskiyou is larger than in any other county in the State, but there were 38 less than in 1912 and 80 less than in 1911. Of these placers, 41 hydraulic mines yielded $124,345 in gold, 1 drift mine $330, and 15 surface placers $5,992. The yield of the single dredge is combined with that of other dredges in Merced and Stanislaus counties to conceal individual outputs. Siskiyou County thus loses individual credit for as much gold as was produced by this dredge. The hydraulic mines produced $92,698 less gold than in 1912, the drift mines $8,851 less, and the surface mines $7,532 less. There are no Federal restrictions affecting hydraulic mining in Siskiyou as there are in the central mining counties of California.

The Trail Creek and Eaton group were the only deep producing mines at Callahan and both were only operated in a small way in 1913, operation being mainly development work. The Lily and Wild Irishman were small producers at Cecilville. At Etna Mills the Highland Mining Co. (Ltd.) and the Homestake were the only producers. The Patterson Creek was the only one at Fort Jones. The Gold Run Mines Co. is producing at Gilta, and the China Gulch and Hungry Creek and Indian Girl mines at Hornbrook. The Eureka

and W. Y. O. D. treat ore by means of a power arastre at Rollin. At Sawyers Bar are the Casey, Lucky Bob, Merriam, and Overton mines.

Of the placers of the county the largest gold producer is the Siskiyou Dredge Co., Fort Jones. At Black Bear the placer operators are Beeson Bros., Raines, Black Bear Gulch, Graham Gulch, Nugget Bar, Orcutt Bros., and Michigan Salmon Mining Co., the combined production of all producers being $18,590 in 1913. The Banner and Johnson are at Cecilville. The Kangaroo, at Callahan, only had water for about a month. The Bloomer and San Quentin mines did hydraulicking at Forks of Salmon, and there were a number of small producers around Fort Jones. The Dutch Creek and the Swiss Gulch mines were operated at Gottville, the Weed & Gradner and a few small mines were productive at Greenview, as were the Kunz Flat, Mullen, and a few other mines at Hamburg. The mines around Happy Camp are mostly hydraulic, and the following claims in 1913 made a combined gold yield of $36,635: Attebury, Additional, Davis Consolidated, Huey Hill, Morning Star, Pennsylvania, and Siskiyou Mines Co. (Williams Point). At Hornbrook, the La Flesh and a few other small hydraulic mines were productive. The Siskiyou Klondike, at Oak Bar, and Frazer, at Rollin, are small hydraulic mines. Most of the mines at Sawyers Bar are hydraulic properties; these mines include the Elliott, Forks of Salmon River, Gold Hill, Multum in Parvo, Thomain, and Burns, the combined gold output of which was $17,237. At Scott Bar are the following hydraulic mines: Boulder Point, Blue Hill, Quartz Hill, and Rocky Point. The producing hydraulic mines at Seiad Valley are the Jerome Mining Co. and Fort Goff; at Somes Bar, the Reynolds Creek; at Walker, the Bark House Creek and Jensen; and near Yreka, the Cable and a few small mines. Of the nonproducing mines of the county the Native Son hydraulic, after an idleness of several years, has been purchased by the Forks of Salmon Mining Co. The Gold Run Mines Co., at Gilta, began milling operations in January, 1914. The China Creek hydraulic, at Evans Ferry, on the Klamath River, after some years idleness, is being reopened in 1914. On the Gray Eagle copper mine, above Happy Camp, about 7,000 feet of adits, drifts, and raises have been made in the course of development work in recent years and the property is now awaiting the arrival of transportation facilities. The Blue Ledge, another large copper property, has about 2 miles of adits and drifts with crosscuts, and 1,000 feet of raises and winzes, but has not shipped any ore.

TRINITY COUNTY.

In 1913 Trinity County produced 20,891.33 fine ounces of gold, valued at $431,862; 3,508 ounces of silver, valued at $2,119; and 341 pounds of lead, valued at $15—a total of $433,996, and a decrease of $297,001 as compared with $730,997 in 1912. There were 72 producing mines in the county in 1913, of which 22 were deep mines and 50 were placers. The deep mines were all gold mines, and of the placers 31 were hydraulic mines, 2 dredges, 1 drift, and 16 surface placers. The deep mines produced from 3,497 tons of ore, 3,548.79 ounces of gold, valued at $73,360, and 1,435 ounces of silver, valued at $867, a total of $74,227 in gold and silver, as compared with $263,186 in 1912,

a decrease of $188,959. The tonnage treated in 1913 was 53,810 tons less than in 1912. This loss is almost entirely due to the closing down in August, 1912, of the Headlight mine owned by the Trinity Gold Mining & Reduction Co., at Carrville, the principal deep mine of the county. The character of ore at this mine changed so that the reduction process in use was not suitable. The 50 placers yielded 17,342.54 fine ounces of gold, valued at $358,502, and 2,073 ounces of silver, valued at $1,252, a total of $359,754, or a decrease of $108,057. There was a material reduction in output from the hydraulic, drift, and surface mines, but the dredges of the county increased their yield by $66,357 in 1913, as compared with 1912. This county, like Siskiyou, is free from all restrictions in hydraulic mining regarding the impounding of the débris or the tailings.

The most productive deep mines in Trinity County in 1913 were the Enterprise & Yellowstone, at Helena, and the Brown Bear, at Deadwood. On the former mine there are two 10-stamp mills with concentrators; on the Brown Bear is a 10-stamp mill, and the mine is developed through tunnels. The Meader, at Carrville, was worked by lessees in 1913. The Golconda at the same place made only a nominal output. The Globe Consolidated Mines Co., at Dedrick, did a good deal of development work in 1913, and at the end of November began operating its new 100-ton cyanide plant. The ore is crushed in a stamp battery in cyanide solution with agitation of all slime pulp, filtering, precipitating, etc. The Gold Bug & Klondike group, at Dorleska, was under lease and was only worked a few months. At Douglas City are the Douglas Queen, Texas Jack, and Oriole mines. The Fritz and Grizzly are small producers at Helena. At Lewiston, are the Gold Hill group, Last Chance, Stofer, and Wood Rat mines. At the Fairview, at Minersville, considerable prospecting was done and the 40-stamp mill was only run a short time. The Bear Tooth and the Quinby Mining Co. properties are at Quinby. At Denny is the Mountain Boomer. The Foster Mining Co. was producing at Trinity Center, and the Tip Top and O'Neal mines are near Weaverville.

Of the placer properties the most productive in the county is that of the Altabert Dredging Co., at Trinity Center. At Big Bar are the Fortune Teller and other small hydraulic mines. The Granite Slide, Swanson, and South Fork are at Burnt Ranch. At Carrville, are the Copper Creek, Morrison Gulch, Nash, and Snow Gulch; and the Gem, Corona de Oro, and Ranney are near China Flat. The placers at Coffee, which are producing, are the Almo, Big Works, Coffee Creek, Underground Treasure, and Trinity Gold Placer Mining Syndicate. The Steiner Flat is the principal hydraulic mine in operation near Douglas, and the Schlomer at Helena. The hydraulic mines at Junction City are the Chapman & Fisher, Red Hill, and Valdor; those at Lewiston are the China Bar, Trinity Dredging Co., Jim Sing, and Mooney Gulch; and those at Quinby are the Log Cabin, McAtee Bar, and New River Mining Co. The Sykes Mining Co. is the only large hydraulic property producing at Trinity Center. At Weaverville are the following hydraulic mining properties, some of them the largest in the State: China Jim, Democrat Gulch, Homestake, La Grange Mining Co., Lorenz, Lucky Strike, Poverty Flat, and Trinity Consolidated Hydraulic Mining Co.—the last-named worked the Union Hill, Hupp, and Brown mines.

TUOLUMNE COUNTY.

Number of mines producing in Tuolumne County, Cal., quantity of ore sold or treated in 1905–1913, and total gold, silver, and lead.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	
1905	43	303,631	$1,298,888	19,076	.....	$1,310,410
1906	34	278,618	1,039,675	12,651	.....	1,048,151
1907	40	194,209	806,876	9,778	6,000	813,647
1908	50	263,216	798,752	22,136	.....	810,484
1909	53	288,618	925,703	8,430	.....	930,087
1910	43	197,737	615,626	10,655	.....	621,380
1911	63	308,652	1,093,484	24,987	.....	1,106,727
1912	53	228,823	1,113,291	40,888	.....	1,138,437
1913	32	236,062	974,409	40,366	.....	998,790
Increase (+) or decrease (−) in 1913	−21	+7,239	−138,882	−522	.....	−139,647

In Tuolumne County in 1913 there was a decrease of 21 in the number of productive mines and a decrease in the output of both gold and silver, but an increase in the quantity of ore treated. The value of the total output of the county decreased by $139,647 in 1913, of which $138,882 was in gold. The county mines produced 47,137.03 ounces of gold, valued at $974,409, and 40,366 ounces of silver, valued at $24,381, a total of $998,790 in gold and silver, as compared with $1,138,437 in 1912. There were 32 producing mines in the county in 1913, of which 26 were deep gold mines and 6 placers, against 53 in 1912, a decrease of 21. The combined output of the placers was 564.34 ounces of gold, valued at $11,666, and 76 ounces of silver, valued at $46, a total of $11,712 in gold and silver, as compared with $6,062 in 1912, an increase of $5,110.

The ore sold or treated in the county in 1913 amounted to 236,062 tons, or 7,239 tons more than in 1912. This ore yielded at the mills $698,076 in gold bullion, an average of $2.96 per ton, and 38,687 ounces of silver, valued at $23,367, an average of $0.10 per ton, a total saved in mill bullion valued at $721,443, or an average of $3.06 per ton in gold and silver. From the milling ore 7,447 tons of concentrates were obtained, which yielded $264,667 in gold, an average of $35.54 per ton, and 1,603 fine ounces of silver, valued at $968, an average of $0.13 per ton, a total of $265,635 in gold and silver, and a total average yield of $35.67 per ton in gold and silver.

The ore milled and concentrated yielded a total of $962,743 in gold, an average of $4.08 per ton, and 40,290 ounces of silver, valued at $24,335, or $0.10 per ton. The total yield of gold and silver on the plates and from the concentrates was valued at $987,078, or $4.18 per ton, as compared with $4.94 per ton in 1912.

As in 1912, so in 1913, the most productive mine in the county was the Black Oak Development Co., at Soulsbyville, where the ore is treated by direct cyanidation. At Big Oak Flat are the Grizzly, Longfellow, and Little Sisters mines. The small output of the Bronx & Luella, at Columbia, was obtained in a test run of the ore. The Experimental Gulch and Old Dominion mines are at the same place. The Gem and Morning Glory mine are at Confidence, and the Cosmopolite was the only producer at Groveland. One of the largest

producers of the county, the Harvard mine (Inc.), is at Jamestown; the mine is equipped with a 60-stamp mill. The Dutch, at Quartz, another large producer, is worked through an incline shaft 1,800 feet deep and about 30,000 feet of drifts on 10 levels. In 1913 the lower levels were retimbered and the 1,650 and 1,800 foot levels were prospected. A new electric hoist was installed, capable of sinking 4,000 feet. The Eagle-Shawmut Mining Co., at Shawmut, another deep producer, operated at about one-third capacity for the first eight months of the year, and was then closed down. The mine has a 100-stamp mill and a 20-ton chlorination plant. The output of the few mines at Sonora was nominal. The Jumper, at Stent, has an 80-stamp mill but only 20 stamps were in commission, the others being dismantled. The 40-stamp mill of the Santa Ysabel, owned by the California Central Mines Co., was only partly operated for one month in 1913. The operators of the Dreisam mine at Tuolumne City, are impounding the tailings for future cyaniding and intend sinking the shaft deeper during 1914. The New Providence Consolidated Mining Co., also at Tuolumne City, is one of the properties of the United Mines Corporation. The producing mines at Tuttletown are the Atlas and Wilson & Means. The few drift placers of the county are at Chinese, Columbia, and Jamestown.

Several of the deep mines of Tuolumne County, formerly large producers, were idle during 1913, and a number of others of less importance, were under development and not productive. The Rosedale Drift Gravel Mining Co. will not start operations until February, 1914. The Stanislaus Gravel Mining Co., a drift mine, continued development during the year, but made no output. The old Draper, at Soulsbyville, is to be unwatered in 1914.

YUBA COUNTY.

Yuba County in 1913 held fourth place in rank of gold production, being exceeded by Nevada, Amador, and Sacramento. As a gravel-mining county Sacramento passed Yuba in dredging output for the year. The output of Yuba County in 1913 was 120,526.55 fine ounces of gold, valued at $2,491,505, and 12,535 ounces of silver, valued at $7,571, a total of $2,499,076, as compared with $2,759,606 in 1912. The decrease in gold for 1913, as compared with 1912, was $261,903. The decrease in gold from dredging operations in the county was $295,742 in 1913, as compared with 1912. There were 12 dredges in operation in the county in 1913 and 14 in 1912. There were 26 placers in operation in the county in 1913, of which 12 were dredges, 1 a drift, and 13 sluicing mines. There were also 2 productive deep mines. The largest producer by far in the county is the Yuba Consolidated Gold Fields, which had 10 dredges operating for seven months and 9 for five months. The Marysville Dredge Co. operated 2 dredges the entire year. Other productive placers were the Bright Star, at Browns Valley; Pepper, at Bullards Bar; American, at Camptonville; Josephine, at Challenge; Archimedes, Gilt Edge, Mammoth, and Sunset, at Marysville. There were some small placers around Browns Valley, Dobbins, Marysville, Smartsville, and at various points along the Yuba River. The only deep mine producers in the county were the California Mother Lode Mining Co. and the Red Cross Gold Mines Co., both at Dobbins.

The following table shows the dredge gold output from the Marysville field for several years past, with the annual decrease or increase, and total:

Mine production of gold of Marysville dredging district, California, 1903–1913, with increase (+) or decrease (−), by years.

Year.	Production.	Increase (+) or decrease (−).	Year.	Production.	Increase (+) or decrease (−).
1903	$25,736		1910	$3,172,476	+$730,557
1904	74,263	+ $48,527	1911	2,964,737	− 207,739
1905	188,967	+ 114,704	1912	2,716,197	− 248,540
1906	1,205,165	+1,016,198	1913	2,420,455	− 295,742
1907	1,688,032	+ 482,867			
1908	1,969,079	+ 281,047	Total	18,867,026	
1909	2,441,919	+ 472,840			

OTHER COUNTIES.

Alpine, Lassen, and Modoc.—Alpine, Lassen, and Modoc counties each made a small production in 1913. The total of Alpine County was $541 in gold and silver from 1 mine; the total of Modoc was $6,155 in gold and silver from 3 deep mines; and the Lassen County output was $352 from 1 deep mine.

Fresno County.—Fresno County had a production of $2,861 in gold and silver from 3 deep mines.

Merced County.—Merced County produced $2,590 in gold and silver from 2 deep mines. The placer production from dredging is combined with the dredge output of Siskiyou and Stanislaus counties.

Imperial County.—Two deep mines in Imperial County yielded $31,700 in gold and 156 ounces of silver, valued at $94, a total of $31,794.

Monterey County.—Monterey County, from 3 deep mines, produced $6,491 in gold and 45 ounces of silver, valued at $27, a total of $6,518.

San Luis Obispo.—In San Luis Obispo County 1 small placer made the nominal yield of $125; and 1 placer in Stanislaus County yielded $201. The dredge in the latter county has its yield combined with other dredges in Siskiyou and Merced counties.

OREGON.

By Charles G. Yale.

PRODUCTION.

Number of mines producing in Oregon, quantity of ore sold or treated, 1905–1913, and total gold, silver, copper, and lead.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	233	150,268	$1,405,235	90,636	846,815	1,610	$1,592,156
1906	279	138,274	1,366,900	79,346	415,803	.....	1,500,212
1907	206	110,698	1,129,261	86,718	554,104	.....	1,297,316
1908	239	50,684	895,076	43,602	291,377	2,138	926,737
1909	162	59,281	781,964	27,827	235,000	400	827,001
1910	180	82,132	679,488	35,978	13,861	.....	700,676
1911	176	98,558	633,407	45,221	93,136	.....	669,016
1912	210	90,945	770,041	57,081	260,429	39,317	849,886
1913	173	155,901	1,627,710	179,036	43,330	87,207	1,746,402
Increase(+)or decrease(−)	−37	+64,956	+857,669	+121,955	−217,099	+47,890	+896,516

Although the number of mines in operation in Oregon decreased by 37 in 1913, as compared with 1912, the tonnage of ore treated was greater in 1913 by 64,956 tons, and there was an increase in quantity and value in all the metals, except copper, the total increase in value being $896,516. This is quite a remarkable showing in view of the fact that since 1905 the output of metals in the State had exhibited a gradual decrease until 1912, when an increase was apparent. The increase in the output of gold in 1913, however, is by no means all attributable to the enlarged tonnage of ore from deep mines, since the placers, and particularly the dredge industry, are largely responsible for the material addition to the quantity of gold. The figures show an output of gold in 1913 more than 111 per cent greater than that of 1912. Considering the total value of the output of all metals in the State in 1913, as compared with 1912, the gold-yield increase is over 95 per cent of the total. The silver output in 1913 was 179,036 fine ounces, as compared with 57,081 ounces in 1912, an increase of 121,955 fine ounces in quantity and of $73,034 in value. This increase was to be expected from the large addition to the tonnage treated for the year. The output of copper fell from 260,429 pounds in 1912 to 43,330 pounds in 1913, a decrease of 217,099 pounds.

In production of lead there was an increase of 47,890 pounds in 1913 over 1912.

The gold values and silver quantities of the table bear no relation to the figures of tonnage of ore (although the other substances do), for the reason that deep mine and placer mine gold and silver are combined to make the total. The gold yield for 1913 was $1,627,710, of which $1,177,082 was derived from deep mines and $450,628 from placers of various kinds. Of the total of 179,036 fine ounces of silver for that year 173,543 fine ounces were from deep mines and 5,493 ounces from the placers. In giving the number of producing mines both placer and deep mines are included.

The production of the total value of $1,746,402 in Oregon in 1913 was derived from 173 producing mines, of which 128 were placers of

various kinds and 45 were deep mines. The number of producing placers decreased by 28 in 1913 and the number of deep mines by 9, resulting in a decrease of 37 producing mines in all. The total quantity of ore mined and treated in 1913 was 155,901 tons, an increase of 64,956 tons. The quantity of siliceous ore sold or treated was 155,704 tons (including 7 tons of slag and 22,858 tons of old tailings), an increase of 69,351 tons. The copper ores sold or treated in 1913 amounted to 122 tons, as compared with 4,569 tons in 1912, a decrease of 4,447 tons. There were 75 tons of lead ore mined and treated in 1913, as compared with 23 tons in 1912, an increase of 52 tons. The average value of the siliceous ore in 1913 was $8.21 per ton in gold and silver, as compared with $6.84 in 1912, $5.03 in 1911, $6.42 in 1910, $9.87 in 1909, and $12.49 in 1908. The copper ore sold or treated in 1913 yielded an average of $17.71 in gold and silver as compared with $4.21 in 1912, as although only a small tonnage was produced it was of a specially high grade. The small quantity of lead ore treated showed the high average in precious metals of $20.01 per ton. Altogether the total output of 155,901 tons of ore yielded an average of $8.29 in gold and silver.

There were treated at gold and silver mills in 1913 in Oregon 92,940 tons of ore, yielding $871,973 in gold, and 39,985 fine ounces of silver, valued at $24,151. In milling the ore at gold and silver mills $782,263 in gold and 35,397 fine ounces of silver were recovered by amalgamation and cyanidation, the average value per ton being $8.417 in gold and $0.230 in silver. From these 92,940 tons of milling ore were recovered 1,018 tons of concentrates, with a gold value of $89,710, and 4,586 fine ounces of silver, valued at $2,770, a total of of $92,480, and an average value of $88.12 per ton in gold and $2.72 in silver. In addition to this there were 38,995 tons of ore sent to concentrating mills, carrying $154,174 in gold and $77,428 in silver, a total of $231,602. Including all concentrates at both gold and silver mills and concentrating mills there was a total of 4,759 tons of concentrates, carrying $243,884 in gold and 132,778 ounces of silver, valued at $80,198, which is an average per ton of $51.24 in gold and $16.85 in silver, and a total of $68.09 per ton in gold and silver. Of the crude ore milled at concentrating and gold and silver mills, the average recovery from bullion and concentrates was $7.78 per ton in gold and $0.77 per ton in silver, a total of $8.55. Crude siliceous ore shipped to smelters amounted to 904 tons containing $100,499 in gold and 3,070 ounces of silver, an average value per ton of $111.17 in gold and $2.05 in silver. In addition there were 122 tons of copper ore treated which yielded $2,067 in gold, 154 ounces of silver, valued at $93, and 32,558 pounds of copper, valued at $5,046. The copper ores yielded $16.94 in gold, 1.26 ounces of silver, and 266.87 pounds of copper per ton. There were 75 tons of lead ore shipped to smelters having an average gold and silver content of $20.01, and an average of 377 pounds of lead per ton. There were 22,858 tons of old tailings treated, yielding $41,829 in gold, and 232 ounces of silver, valued at $140, an average value per ton of $1.83 in gold and $0.006 in silver. In addition to the tailings, there were 7 tons of precipitate treated which yielded $5,300 in gold and $894 in silver, an average of $757.14 in gold per ton and of $127.71 in silver, a total of $884.85 per ton.

GOLD.

The total recoverable gold content of ores and from placers in Oregon in 1913 was 78,740.47 fine ounces, valued at $1,627,710, an increase of 41,489.74 fine ounces in quantity and of $857,669 in value, as compared with the output of 1912. The State, therefore, more than doubled its gold yield for the year, the increase being about 111 per cent. The largest gold yield from one county, valued at $1,373,480, came, as usual, from Baker County, with an increase of $889,439 over the yield in 1912. The next county in rank of gold production was Malheur, followed by Grant, Josephine, Jackson, Lane, Curry, Crook, Douglas, Coos, and Wheeler in the order named. The largest production of gold from both deep and placer mines was from Baker County. The placer mines of the State yielded $450,628 in gold in 1913, as compared with $189,096 in 1912, an increase of $261,532, which may be attributed entirely to the dredge output, the gold from that source having far exceeded all the other forms of placer mining in the State combined. The hydraulic mines yielded $100,250 in gold in 1913, or $50,880 less than in 1912; the drift mines $21,822, or $9,061 more; and the surface placers and dredge combined $328,556, a very material increase for the year. There was only one dredge, a new one, in operation in the State in 1913, California operators having purchased land and built a fine modern dredge to work it. There were 90 productive hydraulic placer mines, 5 drift, and 33 surface placers (including one dredge), or 128 in all in 1913. The total gold output from deep mines in 1913 was 56,941.34 fine ounces, valued at $1,177,082. The mine production of gold in fine ounces, with the classification of ores and increase, for 1912 and 1913, follows:

Mine production of gold in Oregon in 1912 and 1913, by kinds of ore, in fine ounces.

Year.	Placers.	Deep mines.				Grand total.	
		Siliceous ore.	Copper ore.	Lead ore.	Total.	Quantity.	Value.
1912	9,147.52	27,277.97	616.40	208.84	28,103.21	37,250.73	$770,041
1913	21,799.13	56,781.36	99.99	59.99	56,941.34	78,740.47	1,627,710
Increase (+) or decrease (−)	+12,651.61	+29,503.39	−516.41	−148.85	+28,838.13	+41,489.74	+857,669

The gold production from different kinds of mines, by counties, for 1913 is given in the following table:

Source of gold production in Oregon, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placers.	Deep mines.				Grand total.
		Siliceous ore.	Copper ore.	Lead ore.	Total.	
Baker	17,400.54	49,041.56	.....	.....	49,041.56	66,442.10
Coos	78.56	.....	.....	.....	.....	78.56
Crook	14.37	236.02	.....	.....	236.02	250.39
Curry	203.13	61.00	.....	.....	61.00	264.13
Douglas	128.97	.....	.....	.....	.....	128.97
Grant	399.19	2,679.98	.....	.....	2,679.98	3,079.17
Jackson	1,065.75	721.03	.....	.....	721.03	1,786.78
Josephine	1,992.86	265.14	99.99	.....	365.13	2,357.99
Lane	.....	283.38	.....	59.99	343.37	343.37
Malheur	475.48	3,493.25	.....	.....	3,493.25	3,968.73
Wheeler	40.28	.....	.....	.....	.....	40.28
Total	21,799.13	56,781.36	99.99	59.99	56,941.34	78,740.47
Increase (+) or decrease (−)	+12,651.61	+29,503.39	−516.41	−148.85	+28,838.13	+41,489.74

The following table shows the output of placer gold by classes of mines in Oregon, by counties, in 1913:

Value of placer gold output in Oregon in 1913, by counties, by classes of mines.

County.	Hydraulic.	Drift.	Surface including dredge.	Total.
Baker	$20,773	$21,636	$317,292	$359,701
Coos	744	.....	880	1,624
Curry	1,976	.....	2,223	4,199
Crook	.....	.....	297	297
Douglas	2,366	.....	300	2,666
Grant	7,604	.....	648	8,252
Jackson	19,970	.....	2,061	22,031
Josephine	38,118	186	2,892	41,196
Malheur	7,866	.....	1,963	9,829
Wheeler	833	.....	.....	833
Total	100,250	21,822	328,556	450,628

The following table shows the increase or decrease in gold production in Oregon in 1913, by counties:

Increase or decrease in value of gold production in Oregon iy 1913, by counties.

County.	Increase.	Decrease.
Baker	$889,439	.....
Coos	691	.....
Crook	3,670	.....
Curry	.....	$8,151
Douglas	.....	11,475
Grant	41,979	.....
Jackson	.....	26,049
Josephine	.....	27,317
Lane	.....	42,736
Malheur	38,611	.....
Wheeler	.....	993
Total	974,390	116,721
Net increase in 1913	857,669	.....

From the siliceous ore and old tailings in Oregon in 1913 the recovery of gold by processes was as follows: By amalgamation, $573,140; by cyanidation, $250,952. There are no chlorination plants, and as far as returns show, no concentrates were treated by cyanidation, but were shipped to smelters for treatment.

SILVER.

The recoverable silver content of ores and silver from placers in Oregon in 1913 aggregated 179,036 fine ounces, valued at $108,139, an increase of 121,955 ounces in quantity and of $73,034 in value, as compared with the production of 1912. Grant County in 1913 made the largest silver output, 91,656 ounces, valued at $55,361, thus eclipsing Baker County, which has usually been the largest producer of silver. Heretofore Grant County has made only a nominal output of silver; its large yield for 1913 was mainly due to the operation of one mine. Baker County comes next in rank in silver yield, the output in 1913 being 79,182 ounces, valued at $47,826, which is about double the quantity and value of 1912. From the other counties of the State the yield shown is only nominal. The placer mines of Oregon yielded 5,493 fine ounces, valued at $3,318, as compared with 1,941 ounces, valued at $1,194, in 1912. The deep mines yielded 173,543 ounces, valued at $104,821; of this, 154 ounces came from copper ores and 432 ounces were from lead ores, the remainder, 172,957 ounces, being derived from siliceous ore. The total increase of 121,955 ounces of silver was derived from siliceous ore, there being a smaller quantity from both copper and lead ores than in 1912. From the siliceous ore and old tailings treated in Oregon in 1913 the recovery of silver by amalgamation was 4,712 fine ounces and by cyanidation 30,919 ounces. This high recovery by cyanidation is due mainly to the operation of one mine, which, in cyaniding 22,297 tons of ore, recovered 11,545 ounces of gold and 30,847 ounces of silver.

The source of silver, by kinds of ore and by counties, in 1913, is shown in the following table:

Source of silver production in Oregon, by kinds of ore, in 1913, in fine ounces.

County.	Placers.	Deep mines.				Grand total.
		Siliceous ore.	Copper ore.	Lead ore.	Total.	
Baker	4,275	74,907			74,907	79,182
Coos	13					13
Crook	298	780			780	1,078
Curry	276	8			8	284
Douglas	23					23
Grant	68	91,588			91,588	91,656
Jackson	182	975			975	1,157
Josephine	273	33	154		187	460
Lane		1,388		432	1,820	1,820
Malheur	77	3,278			3,278	3,355
Wheeler	8					8
Total	5,493	172,957	154	432	173,543	179,036
Increase (+) or decrease (−)	+3,552	+128,939	−10,401	−135	+118,403	+121,955

COPPER.

The mine production of copper in Oregon in 1913 was 43,330 pounds, valued at $6,716, a decrease of 217,099 pounds in quantity and of $36,255 in value from the yield of 1912. The copper ore also carried gold to the value of $2,067 and silver to the value of $93.

LEAD.

In 1913 Oregon produced 87,207 pounds of lead, valued at $3,837, as compared with 39,317 pounds, valued at $1,769 in 1912. Lead was produced in six counties of the State, Lane County having the largest yield, although a considerable quantity came also from Baker County.

MINING INDUSTRY IN OREGON IN 1913.

Not since 1902 has Oregon produced as much gold and silver as in 1913. Indeed, between 1908 and 1912 inclusive, the combined value of the gold, silver, copper, and lead of the State fell below the million dollar mark. The increase in 1913 should be a very encouraging fact to the miners of Oregon, as it clearly proves material progress in the mining industry and gives a hopeful view for the future. The importance of the gold-mining industry in the State is paramount, 93.20 per cent of the total value of the combined metals being gold. The material increase of production in Oregon is in the face of the fact that there were 9 less deep mines reporting production in 1913 than in 1912, and 28 less placers, or 37 less producing mines in all. The increase in gold is due to larger output from the more prominent deep mines and the operations of one dredging company which commenced operations early in the year. As a result of the success of this company, different portions of Oregon are being examined for possible dredging areas and some of the promising ground is being prospected.

There are very few extensive mining operations being conducted in Oregon, most of the properties being comparatively small producers. Of the deep mines in the State there are only 5 which are yielding over $100,000 per annum, these being the Highland, Cornucopia Mines, Columbia, and Rainbow, all in Baker County, and the Ben Harrison in Grant County. Of the placer mines yielding annually over $10,000 there are only 4, the Powder River dredge, the Boulder Creek hydraulic, and the Snyder Consolidated hydraulic, all in Baker County, and the Tom East in Josephine County.

The southwestern counties of Oregon,[1] which form an extension of the California gold belt, are Benton, Coos, Curry, Douglas, Jackson, Josephine, and Lane. These counties (with the exception of Benton, which made no output), made in 1913 a combined production in gold of $102,528 and of 3,757 ounces of silver, valued at $2,270. The production of placer gold in this region in 1913 was $71,716, a decrease of $54,667, and the gold production from deep mines was $30,812, a decrease of $60,370. The total decrease of gold output in these

[1] Diller, J. S., Mineral resources of southwestern Oregon, U. S. Geol. Survey Bull. 546, pp. 9–127, 1914. Diller, J. S., and Kay, G. F., Mines of the Riddles Quadrangle, Oregon, U. S. Geol. Survey Bull. 340, pp. 134–152, 1908.

southwestern counties in 1913, as compared with 1912, was, therefore, $115,037. For some years there has been an evident decrease of gold output from these counties until 1912 when there was a material increase over 1911, but now another decrease is apparent.

Northeastern Oregon comprises the counties of Baker, Crook, Grant, Harney, Malheur, Umatilla, Union, Wallowa, and Wheeler. In 1913 the counties of Harney, Umatilla, Union, and Wallowa returned no production. The combined gold output of the five producing counties of this region, Baker, Crook, Grant, Malheur, and Wheeler, in 1913 was $1,525,182, of which Baker County contributed $1,373,480, or 90 per cent. This is an increase for 1913 of these counties, as compared with 1912, of $972,706. The placer gold yield in 1913 was $378,912, an increase of $316,199, or 491.04 per cent. The lode mines produced in gold $1,146,270 in 1913, as compared with $489,763 in 1912, an increase of $656,507 for 1913, or 134 per cent.

The subdivision of tonnage and production of gold and silver in Oregon in 1913, according to methods of treatment, is shown in the following table:

Subdivision of tonnage and production of gold and silver in Oregon, in 1913, according to methods of treatment, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.	Concentrates treated.		
	Quantity.	Gold.	Silver.	Quantity.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*	*Short tons.*		*Fine ounces.*
Baker	78,318	$703,835	34,142	15,185	3,235	$172,232	37,076
Crook				130	26	972	13
Curry	60	1,261	8				
Grant	91	788	15	23,620	1,110	54,612	91,574
Jackson	818	9,877	172		25	879	485
Josephine	125	4,158	25				
Lane	1,300	2,173	38	60	145	3,148	1,348
Malheur	12,228	60,171	997		218	12,041	2,282
Total	92,940	782,263	35,397	38,995	4,759	243,884	132,778
Average value per ton		8.417	$0.23			51.24	$16.85

Average recovery value (per ton) from both bullion and concentrates: Gold $7.78, silver $0.77.

County.	Crude ore to smelter.			Old tailings treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*		*Fine ounces.*
Baker	672	$90,583	1,977	22,865	$47,129	1,712
Crook	50	3,907	767			
Curry						
Grant						
Jackson	104	4,149	316			
Josephine	175	3,390	162			
Lane	100	1,777	434			
Malheur						
Total	1,101	103,806	3,656	22,865	$47,129	1,712
Average value per ton		94.28	2.005		2.061	$0.045

The total tonnage, by kinds of ore sold or treated, in each county in Oregon in 1913, is shown in the following table:

Subdivision of tonnage of ore sold or treated in Oregon in 1913, by counties, in short tons.

County.	Siliceous ore.	Copper ore.	Lead ore.	Total ore.
Baker	117,040	.....	.....	117,040
Crook	180	.....	.....	180
Curry	60	.....	.....	60
Grant	23,711	.....	.....	23,711
Jackson	922	.....	.....	922
Josephine	178	122	.....	300
Lane	1,385	.....	75	1,460
Malheur	12,228	.....	.....	12,228
Total	155,704	122	75	155,901
Increase (+) or decrease (−)	+69,351	−4,447	+52	+64,956
Value per ton in gold or silver	$8.21	$17.71	$20.01	$8.22

The following table gives the number of producing mines, classified according to their chief product, in the counties of Oregon in 1913:

Number of mines classified by chief product, in Oregon in 1913, by counties.

County.	Gold placer mines.				Deep mines.					Total producing mines.
	Hydraulic.	Drift.	Surface.	Total.	Gold.	Silver.	Copper.	Lead.	Total.	
Baker	15	4	8	27	14	.....	.....	.....	14	41
Coos	2	.....	2	4	.....	.....	.....	.....	.....	4
Crook	.....	.....	1	1	2	.....	.....	.....	2	3
Curry	3	.....	3	6	1	.....	.....	.....	1	7
Douglas	10	.....	1	11	.....	.....	.....	.....	.....	11
Grant	14	.....	3	17	3	.....	.....	.....	3	20
Jackson	13	.....	4	17	9	.....	.....	.....	9	26
Josephine	22	1	9	32	6	.....	2	.....	8	40
Lane	.....	.....	.....	.....	4	.....	.....	1	5	5
Malheur	9	.....	2	11	3	.....	.....	.....	3	14
Wheeler	2	.....	.....	2	.....	.....	.....	.....	.....	2
Total	90	5	33	128	42	.....	2	1	45	173

The following table shows the mine production of gold, silver, copper, and lead in Oregon in 1913, by counties, with the tonnage:

Production of precious metals in Oregon in 1913, by source, and production of copper and lead, by counties.

County.	Ore treated.	Quartz gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ozs.*		*Fine ozs.*		*Fine ozs.*	
Baker	117,040	49,041.56	$1,013,779	17,400.54	$359,701	66,442.10	$1,373,480
Coos	.....	.....	.....	78.56	1,624	78.56	1,624
Crook	180	236.02	4,879	14.37	297	250.39	5,176
Curry	60	61.00	1,261	203.13	4,199	264.13	5,460
Douglas	.....	.....	.....	128.97	2,666	128.97	2,666
Grant	23,711	2,679.98	55,400	399.19	8,252	3,079.17	63,652
Jackson	922	721.03	14,905	1,065.75	22,031	1,786.78	36,936
Josephine	300	365.13	7,548	1,992.86	41,196	2,357.99	48,744
Lane	1,460	343.37	7,098	.....	.....	343.37	7,098
Malheur	12,228	3,493.25	72,212	475.48	9,829	3,968.73	82,041
Wheeler	.....	.....	.....	40.28	833	40.28	833
Total	155,901	56,941.34	1,177,082	21,799.13	450,628	78,740.47	1,627,710

Production of precious metals in Oregon in 1913, by source, and production of copper and lead, by counties—Continued.

County.	Quartz silver.		Placer silver.		Total silver.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Fine ozs.*	
Baker	74,907	$45,244	4,275	$2,582	79,182	$47,826
Coos			13	8	13	8
Crook	780	471	298	180	1,078	651
Curry	8	5	276	167	284	172
Douglas			23	14	23	14
Grant	91,588	55,320	68	41	91,656	55,361
Jackson	975	589	182	110	1,157	699
Josephine	187	113	273	165	460	278
Lane	1,820	1,099			1,820	1,099
Malheur	3,278	1,980	77	46	3,355	2,026
Wheeler			8	5	8	5
Total	173,543	104,821	5,493	3,318	179,036	108,139

County.	Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Baker	2,783	$431	19,796	$871	$1,422,608
Coos					1,632
Crook			684	30	5,857
Curry					5,632
Douglas					2,680
Grant	424	66	162	7	119,086
Jackson			433	19	37,654
Josephine	32,558	5,046	6,928	305	54,373
Lane	7,565	1,173	59,204	2,605	11,975
Malheur					84,067
Wheeler					838
Total	43,330	6,716	87,207	3,837	1,746,402

PRODUCTION BY COUNTIES.[1]

BAKER COUNTY.

Mine production of gold, silver, copper, and lead, in Baker County, Oreg., 1905–1913.

Year.	Number of mines producing.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	37	75,033	$771,607	55,161	3,200		$805,423
1906	51	58,889	795,653	53,708	185		736,673
1907	46	69,881	631,045	69,580			676,974
1908	50	38,413	507,929	17,495			517,202
1909	42	32,521	417,538	19,514			427,685
1910	54	56,263	401,002	29,835	13,861		418,873
1911	34	74,558	389,786	30,944			406,186
1912	49	70,631	484,041	39,140	951		507,269
1913	41	117,040	1,373,480	79,182	2,783	19,796	1,422,608
Increase (+) or decrease (−) in 1913	−8	+46,409	+889,439	+40,042	+1,832	+19,796	+915,339

[1] For reference to United States Geological Survey publications on the mining districts of Oregon, see Hill, J. M., The mining districts of the western United States: U. S. Geol. Survey Bull. 507, 1912.
See also Diller, J. S., Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, 1914.

The total value of all metals mined in Baker County in 1913 was $1,422,608, as compared with $507,269 for 1912, an increase of $915,339. There were fewer producing mines than in 1912, but quantities and values in all metals showed material increases. The most marked advance was in the output of gold, the increase alone being about double the entire output of the county in 1912. The increase was due to both deep and placer mine output. The silver increased by 40,042 ounces in quantity, the total being valued at $47,826 as compared with 39,140 ounces, valued at $24,071 in 1912. The copper output was 2,783 pounds as compared with 951 pounds in 1912. The yield of lead was 19,796 pounds, valued at $871 in 1913; there was no yield of this metal in 1912. There were 41 mines which reported production in the county in 1913, a decrease of 8 as compared with 1912. The placers numbered 27, of which 15 were hydraulic, 4 were drift, 7 were sluicing mines, and 1 was worked by a dredge. The placers yielded $359,701 in gold and 4,275 ounces of silver, valued at $2,582, as compared with $37,834 in gold and 574 ounces of silver in 1912. The number of producing deep mines was 14, or 9 less than in 1912. The total output of siliceous ore mined and treated in the county in 1913 was 117,040 tons, or 47,124 tons more than in 1912. The gold yield of this ore was valued at $1,013,779 and the silver yield was 74,907 fine ounces, valued at $45,244. The average recoverable value of the ore per ton was $8.66 in gold and 39 cents in silver, a total of $9.05 per ton in 1913, as compared with $6.32 in gold and 34 cents in silver, a total of $6.66 per ton in 1912, and $4.99 in gold and 22 cents in silver, or $5.21 per ton in 1911. Of the total of 117,040 tons of siliceous ore, 78,318 tons were treated at gold and silver mills and yielded $703,835 in gold and 34,142 ounces of silver (valued at $20,622), by amalgamation and cyanidation, an average per ton of $8.99 in gold and 26 cents in silver. From the 78,318 tons of milling ore were derived 614 tons of concentrates, yielding $73,276 in gold and 548 ounces of silver (valued at $331), a total value of $73,607, or an average value of $119.88 per ton. The total yield of the 78,318 tons of milling ore from the plates, direct cyanidation, and from the concentrates was $777,111 in gold and $20,953 in silver, an average of $9.92 per ton in gold and 27 cents in silver, a total recovery of $10.19 per ton in gold and silver. In addition to this there were 15,185 tons of ore sent to concentrating mills which yielded 2,621 tons of concentrates, valued at $98,956 in gold and 36,528 ounces of silver, valued at $22,063, an average value per ton of concentrates in gold and silver of $46.17. Crude ore was shipped to smelters to the amount of 672 tons, and yielded in gold $90,583 and in silver 1,977 ounces, valued at $1,194, a total value for the smelting ores of $91,777 in gold and silver, or an average of $136.57 per ton. In addition to this there were 22,865 tons of old tailings treated, yielding $47,129 in gold and 1,712 ounces of silver, valued at $1,034, an average value of $2.11 per ton in gold and silver.

Baker district.—There were four productive deep mines and four productive placers in this district in 1913, their yield being $9,144 in placer gold and $48 in placer silver, and $101,824 in gold and $22,078 in silver from deep mines—a total of gold and silver of $133,094. There was also an output of 14,600 pounds of lead valued at $642, making the district total for the year of $133,736. The

Highland was the most productive of the deep mines; it is equipped with a concentrating mill. The placers of the district are all small sluicing properties.

Cable Cove district.—The only active mines in this district are deep ones—the Last Chance & Baby McKee group, and the Imperial—the latter supplying ore to the smelter at Midvale, Utah.

Connor Creek district.—Of the producing placers the Huntington and Neversweat are drift mines, and there are a few small sluicing properties.

Cornucopia district.—Three deep mines and 1 placer in this district made a combined yield of $299,481 in gold and silver in 1913. The Cornucopia Mines Co., of New York, operating the Union and Last Chance mines, was the largest producer. The property is equipped with a 20-stamp mill and a 100-ton cyanide plant. The Bonanza Mining Co. also produced. On the Boulder Creek property both drifting and hydraulicking are carried on.

Cracker Creek district.—There were 3 deep mines and 3 placers in this district, with a combined gold and silver value in 1913 of $601,287, and in addition some small values in copper and lead. The deep mines are the Columbia, the Northwest Smelting & Refining, and the Weatherby Bonanza group. The Northwest Co. shipped only a small quantity of material from cleaning up around the smelter and produced no ore. The Powder River dredge in this district is the only one operating in the State.

Bridgeport, Durkee, Granite, and Virtue districts.—In Bridgeport there was 1 productive placer in 1913, in Durkee 1, in Virtue 1, and in Granite district 2. The only one of importance is the drift mine of the Snyder Consolidated Mining Co. (Ltd.), at Robinette, in Granite district.

Mormon Basin and Pine Creek districts.—The only deep mine of importance producing in Mormon Basin district is the Rainbow Commercial, which has a 15-stamp mill and a cyanide plant and is the largest producer in Oregon. The placers are the Deer Creek, Rye Valley, Chicken Creek, Little Hill, and Matsberger, all hydraulic mines on a small scale. The six placers in Pine Creek district are all small hydraulic or drift mines.

COOS AND CROOK COUNTIES.

Coos County produced $1,624 in gold and $8 in silver in 1913, as compared with $933 in gold and $6 in silver in 1912. This came from 4 small placers—1 in Randolph district, 2 in Sixes River, and 1 in Whiskey Run district. An output of $5,176 in gold and 1,078 ounces of silver, valued at $651, and 684 pounds of lead, valued at $30, came from 2 deep mines and 1 placer in Crook County in 1913; the deep mines are the Mayflower and the Ochico in Howard district, and the placer is the Sunset, at Howard.

CURRY AND DOUGLAS COUNTIES.

In Curry County 6 placers and 1 deep mine in 1913 made a combined production of $5,632 in gold and silver. The deep mine is the Alpine, in Mule Creek district. The placers are the Myrtle, in Elk River

district, Gold Bar, in Gold Bar district, Baileys Head, in Gold Beach district, Old Diggins, in Lobster Creek district, and ocean beach mines in Ophir district.[1] In Douglas County are 11 small producing placers including the Picayune at Canyonville, Coffee Creek and Texas at Perdue, Ash at Riddle, Boulder, Hogan, and Starvout at Booth, and Dyer at Myrtle Creek. Their combined output for 1913 was $2,680 in gold and silver.

GRANT COUNTY.

The production of Grant County in 1913 was $63,652 in gold and 91,636 ounces of silver, valued at $55,361; also 424 pounds of copper, valued at $66, and 162 pounds of lead, valued at $7, a total of $119,086. The total value of the output of the county in 1912 was $22,032, the increase for 1913 being $97,054. This yield makes Grant rank next to Baker County in output, taking this rank from Josephine, which has usually been second. There were 3 deep and 17 productive placers in Grant County in 1913. The deep mines are the Ben Harrison, in Granite district (the largest producer in the county); Morning, in Alder Creek district; and Dixie Meadow, in Quartzburg district. These deep mines produced 23,711 tons of ore, yielding $55,400 in gold and 91,588 ounces of silver, valued at $55,320, with a small quantity of copper and lead. Most of this output was shipped to smelters in the form of concentrates. Of the 17 productive placers in this county in 1913, nearly all were hydraulic properties. These are the Black Butte, in Beach Creek district; Gray Eagle, in Miller Mountain district; Caledonia, in Marysville district; Humboldt, Marysville, and Quartz Gulch, in Canyon Mountain district; Independence, at Sumpter; Belmont and Mohawk, at Austin; Elk Creek, at Galena; and Maisie Ridge, at Susanville.

JACKSON COUNTY.

In Jackson County there were 9 productive deep mines and 17 placers; of the latter 13 are hydraulic and 4 are sluicing mines. The placers yielded $22,031 in gold and 182 ounces of silver, valued at $110, with a total value of $22,141; and the deep mines yielded $14,905 in gold and 975 ounces of silver, valued at $589, a total of $15,494. The value of the output of the county in 1913 (including a small quantity of lead) was $37,654. In Applegate district the Afterthought is the only deep mine, and the Pittock Brothers and the Ray are hydraulic properties. In Foots Creek district the Nellie Wrigert and the Treasure are the productive deep mines and the placers are the Iron Gulch and Black Channel hydraulic claims. In Forest Creek district, the hydraulic mines are the Lone Pine, Vance Sturgis, Taylor Creek, and Spaulding. At Jacksonville there is one small surface placer, and the Medford Mining Co. is the producing deep mine, which ships its ore to the Mammoth Smelter in Shasta County, Cal. In Kanes Creek district the Gold Ridge is a small deep mine and the Electric Gold Dredge Co. is hydraulic. In the Pearl district the Pearl-Buzzard Mining Co. is operating a deep mine. At

[1] See Day, D. T., and Richards, R. H., Investigation of black sands from placer mines: U. S. Geol. Survey Bull. 285, pp. 150–164, 1906. Kemp, J. F., The geological relations and distribution of platinum and associated metals: U. S. Geol. Survey Bull. 193, pp. 51–53, 1902.

Pleasant Creek are a few small placers only. The Lucky Bart group is operating a 5-stamp mill on its mine in Sardine district, and there is also one sluicing property being worked. In Sterling district the Sterling placer was operated.

JOSEPHINE COUNTY.

The total output of gold, silver, copper, and lead in Josephine County in 1913 was valued at $54,373, as compared with $124,660 in 1912, a decrease of $70,287. The gold yield was $48,744, the silver 460 ounces, valued at $278, the copper 32,558 pounds, valued at $5,046, and the lead 6,928 pounds, valued at $305. The deep mines of the county produced 300 tons of ore in 1913. The output from these combined deep mines was 365.15 fine ounces of gold, valued at $7,548; 187 ounces of silver, valued at $113; and all of the copper and lead produced. The value of the deep mine product of the county was, therefore, in all metals, $13,012. Of the placer gold $38,118 came from hydraulic mines, $186 from a drift mine, and $2,892 from surface or sluicing mines. In 1913 the placer gold output decreased $17,023. The decrease in total gold in 1913, as compared with 1912, was $27,317, both placer and deep mines showing a falling off in output. Of the ore produced, 125 tons were treated at gold and silver mills and 175 tons were shipped to smelters. In connection with this decrease of output in the county for the year, it may be stated that the returns from one of the prominent producers were not received until too late for entry or classification in this report.

A table follows which shows the output of metals from the various mining districts of Josephine County in 1913. In this table, however, it is to be noted that the values of copper and lead in Galice and Waldo districts is deducted from the totals of those districts, in order to conceal individual yield of certain mines, these copper and lead values being added at the bottom of the table so that the figures shall balance and the grand total be correct.

Value of output of gold and silver and quantity of copper and lead of Josephine County, Oreg., mining districts in 1913.

District.	Placer gold.	Quartz gold.	Placer silver.	Quartz silver.	Copper	Lead.	Total.
					Pounds.	*Pounds.*	
Althouse	$1,280	.....	$6	.....	.....	.....	$1,286
Applegate	250	.....	1	.....	.....	.....	251
Briggs Creek	2,500	.....	11	.....	.....	.....	2,511
Galice	1,092	$2,646	6	$79	.....	.....	3,823
Grave Creek	18,976	1,700	68	6	.....	.....	20,750
Illinois	.....	413	.....	2	.....	.....	415
Josephine	3,414	.....	13	.....	.....	.....	3,427
Jump-off-Joe	4,806	831	23	20	.....	.....	5,680
Kerby	77	.....	1	.....	.....	.....	78
Pickett Creek	2,645	.....	16	.....	.....	.....	2,661
Sucker Creek	.....	1,758	.....	5	.....	.....	1,763
Waldo	3,072	200	6	1	.....	.....	3,279
Williams	1,275	.....	4	.....	.....	.....	1,279
Wolf Creek	1,809	.....	10	.....	.....	.....	1,819
Copper	.....	.....	.....	.....	32,558	.....	5,046
Lead	.....	.....	.....	.....	.....	6,928	305
Total	41,196	7,548	165	113	32,558	6,928	54,373

The producing mines in the Althouse district are all placers and are the Deadman Gulch, Goldsby, Little Homestead, and Rambler.

There is one producing placer in Applegate district and one in Briggs Creek district.

In the Galice district is the Almeda Consolidated Mines Co. and the Argo, both deep mines, and the Crescent and Martin & Daniels, placers.

Grave Creek district has one deep mine and several placer mines. The placers are the Archer, Goff Abbott, Steam Beer, Browning, and Tom East hydraulic mines, the last named being the most important.

The three hydraulic mines in Josephine district are the Canyon Creek, Gold Leaf, and Anderson.

In Jump-Off-Joe district the deep mines are the Grants Pass and the Goodnow; the hydraulic mines are the Cook & Howland and the Swastika.

In Waldo district there is but one deep mine and there are two hydraulic mines, the Deep Gravel and the Simmons-Cameron.

In Wolf Creek district the Bend, the Ruble, and the Blue Channel are hydraulic mines, and the Copper Knob and the Sarah Bell are sluicing properties.

In Illinois district there is one productive deep mine; in Kerby district, 1 sluicing mine; in Pickett Creek district, 2 placers; in Sucker Creek district, 1 deep mine; and in Williams district 1 hydraulic mine.

LANE COUNTY.

In 1913 Lane County produced 343.37 fine ounces of gold, valued at $7,098; 1,820 ounces of silver, valued at $1,099; 7,565 pounds of copper, valued at $1,173; and 59,204 pounds of lead, valued at $2,605—a total of $11,975, as compared with $53,303 in 1912. This was a decrease of $41,328, there being a decrease of $42,736 in gold and a slight increase in all the other metals. There were 2 productive deep mines in Blue River district, the Consolidated Lucky Boy and the Mitchell. In Bohemia district were the West Coast, the Vesuvius, and the B & Z mines.

MALHEUR AND WHEELER COUNTIES.

The total yield from Malheur County from 3 deep mines and 11 placers was $82,041 in gold and 3,355 fine ounces of silver, valued at $2,026; a total of $84,067, as compared with $43,680 in 1912, an increase of $40,387. The gold increased $38,611 in 1913. There was 1 placer mine in Dry Buck district and 1 in Humboldt district. In Malheur Basin district are the Moy Kee, Littig, and Quartz Gulch hydraulic mines. Mormon Basin was the principal producing district of the county. The hydraulic producers are the Archer & Hansen, Colt Brothers, and Glengary. The productive deep mines are the Red, White and Blue and the Humboldt Consolidated gold mines, the latter by far the most productive in the county. The property is equipped with a 20 stamp mill.

In Wheeler County the total yield was $833 in gold and $5 in silver, as compared with $1,826 in gold and $8 in silver in 1912. The output was from 2 hydraulic mines in Spanish Gulch district.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON GOLD, SILVER, COPPER, LEAD, AND ZINC IN OREGON.[1]

DILLER, J. S., Mineral resources of southwestern Oregon: Bull. 546, 1914.

——— The Bohemia mining region of western Oregon, with notes on the Blue River mining region: Twentieth Ann. Rept., pt. 3, pp. 7–36, 1900. $1.50.

DILLER, J. S., and KAY, G. F., Mineral resources of the Grants Pass quadrangle and bordering districts, Oregon: Bull. 380, pp. 48–79, 1909. 40c.

DILLER, J. S., The mines of the Riddles quadrangle, Oregon: Bull. 340, pp. 134–151, 1908. 30c.

LINDGREN, WALDEMAR, The gold belt of the Blue Mountains of Oregon: Twenty-second Ann. Rept., pt. 2, pp. 551–776, 1901. $2.25.

——— Copper deposits of Snake River, Oregon: Twenty-second Ann. Rept., pt. 2, pp. 629–634, 747–752, 1901. $2.25.

MACDONALD, D. F., Notes on the Bohemia mining district, Oregon: Bull. 380, pp. 80–84, 1909. 40c.

PARDEE, J. T., Placer gravels of the Sumpter and Granite districts, eastern Oregon: Bull. 430, pp. 59–65, 1910.

——— Faulting and vein structure in the Cracker Creek gold district, Baker County, Oreg.: Bull. 380, pp. 85–93, 1909. 40c.

[1] The publications for which a price is given are no longer available for free distribution but can be purchased from the Superintendent of Documents, Washington, D. C.; others can be obtained free on application to the Director of the United States Geological Survey, Washington, D. C.

COPPER.

By B. S. Butler.

INTRODUCTION.

In the production of metallic copper suitable for commercial purposes at least three distinct processes are usually required, namely, mining, smelting, and refining. The Lake Superior native copper district is the only important producer where these three processes are not entirely distinct. It is possible, therefore, to ascertain the copper output of the country by collecting statistics from the mines, from the smelters, and from the refineries, and each of these sets of figures has its advantages. The mine figures have the advantage of giving the most accurate distribution of the production but are less accurate in total quantity of copper recovered; the smelter figures permit of reasonably accurate distribution and also furnish the actual recovery of copper from the ores treated during the year; the refinery figures furnish the best measure of the copper made available for commercial uses during the year, but at this stage of manufacture the accurate distribution to the State of origin, or even the separation of copper derived from domestic and from foreign sources, is uncertain.

Statistics for 1913 showing the production of each of these stages of manufacture have been collected by the United States Geological Survey, and are presented in the following report.

Since the same material passes through the three processes of manufacture at successive periods, usually requiring two to three months from the time it is taken from the mine before it reaches the stage of refined copper, the year's production as recorded for the different stages does not represent the same materials—that is, the refinery production for the calendar year 1913 represents the mine production from about October 1, 1912, to October 1, 1913. The three sets of figures representing the successive stages of manufacture do not therefore necessarily agree, although they should not differ greatly if the condition of the industry is normal. The mine and the smelter figures will differ by the difference in the quantity of ore, matte, etc., in stock at the beginning and at the end of the year and by the difference in the quantity of copper reported by the mines and that recovered by the smelters. This difference is due to the fact that considerable copper is recovered from sulphur, lead, zinc, and siliceous ores carrying values in copper so low that the mines do not receive pay for and frequently do not report the copper content of the ore, although it is eventually recovered by the smelters. The smelter and refinery figures will differ by the increase or decrease in stock of blister, etc., at the beginning and at the end of the year and by the loss in refining.

Since the smelter production permits reasonably accurate distribution as to source by States and also gives the actual output of copper, it is adopted in this report as the production of the country. It is made up of the production of blister copper and of furnace-refined or ingot copper of the Lake district.

SUMMARY OF STATISTICS.

The following statistical statement summarizes the copper industry in the United States in 1910, 1911, 1912, and 1913:

Summary of statistics of the copper industry in the United States in 1910, 1911, 1912, and 1913.

	1910	1911	1912	1913
Production of copper:				
Smelter output.....pounds..	1,080,159,509	1,097,232,749	1,243,268,720	1,224,484,098
Mine production.....do....	1,088,237,432	1,114,764,197	1,249,094,891	1,235,569,727
Refinery production of new copper—				
Electrolytic.....do....	782,171,204	823,507,764	914,935,371	1,022,497,601
Lake.....do....	221,462,984	218,185,236	231,112,228	155,715,286
Casting and pig.....do....	68,260,688	59,577,803	57,629,296	58,611,026
Total domestic.....do....	1,071,894,876	1,101,270,803	1,203,676,895	1,236,823,913
Total domestic and foreign.....do....	1,422,039,135	1,433,875,026	1,568,104,478	1,615,067,782
Total new and old copper.....do....	1,610,000,000	1,648,000,000	1,843,000,000	1,888,000,000
Total ore produced.....short tons..	28,517,556	29,994,942	35,671,028	36,361,101
Copper ore produced.....do....	28,497,123	29,988,235	35,656,414	36,336,682
Average yield of copper.....per cent..	1.88	1.825	1.71	1.67
Imports.....pounds..	344,435,771	334,607,538	410,240,295	409,560,954
Exports.....do....	708,316,543	786,553,208	775,000,658	926,441,142
Consumption:				
Total new copper.....do....	732,400,000	681,753,279	775,978,332	812,068,639
Total new and old copper.....do....	941,400,000	895,900,000	1,051,000,000	1,085,000,000
World's production.....do....	1,903,297,003	1,954,957,560	2,259,101,580	2,198,732,130
Value of production in the United States.....	$137,180,257	$137,154,092	$205,139,338	$189,795,035

Production of copper in the United States in 1912 and 1913.

[Smelter output, in pounds fine.]

	1912	1913		1912	1913
Alaska	31,926,209	23,423,070	Pennsylvania	248,378	245,337
Arizona	359,322,096	404,278,809	Philippine Islands	.....	22
California	31,516,471	32,492,265	South Dakota	23,657	4,549
Colorado	7,963,520	9,052,104	Tennessee	18,395,256	19,489,654
Idaho	7,182,185	8,711,490	Texas	964	39,008
Maryland	53,043	.....	Utah	132,150,052	148,057,450
Michigan	231,112,228	155,715,286	Vermont	.....	5,771
Missouri	440,725	576,204	Virginia	96,753	46,961
Montana	308,770,826	285,719,918	Washington	1,069,938	732,742
Nevada	83,413,900	85,209,536	Wyoming	25,080	362,235
New Mexico	29,170,400	50,196,881	Undistributed	11,413	46,803
North Carolina	63,766	180			
Oklahoma	.....	11	Total	1,243,268,720	1,224,484,098
Oregon	311,860	77,812			

GENERAL CONDITION OF THE INDUSTRY.

The smelter production of copper in 1913 showed a slight decrease from that of 1912. This decrease was due to abnormal conditions in certain districts, otherwise there would have been a substantial increase. These conditions affected especially the output of the Lake Superior district, where a strike of miners was in progress for over five months of the year. The decrease in Alaska was due to the partial destruction of the plant of the largest producer of that Dis-

trict, and the decrease in Montana can be attributed in part to unusual conditions.

There were no important new producers added during 1913, but there were notable increases made in the production of several companies that have recently entered the producing class.

The refinery production was the largest in the history of the industry, the excess over the smelter production resulting in a material reduction in the stocks of unfinished material.

There is no doubt that the cost of producing copper was considerably higher for 1913 than for the preceding year. This may be attributed to several causes, the most important of which is probably the decrease in the metal content of ore treated from an average of 1.71 per cent in 1912 to 1.67 per cent in 1913. Among other causes are increase in taxes, and increase in cost of labor in certain camps, due to a decrease in working hours. A compilation of the cost per pound by companies giving this item in their annual reports, the Lake mines excepted, shows an average increase of 0.65 cent a pound.

The selling price of copper for 1913 averaged about 1 cent a pound less than for 1912. It is therefore evident that the profits for the year were materially lower than for the preceding year, though there was a good profit on most of the copper produced.

Perhaps the most notable feature of the industry for the year was the improvement in metallurgy. Most earnest and, in many places, successful efforts are being made to increase the percentage of recovery from ores. This has resulted in the partial or complete rebuilding of several smelting plants and in important changes and additions to concentrating mills. One of the most interesting and important activities has been the experimentation with leaching processes for the treatment of mill tailings and low-grade oxidized and partially oxidized ores. Leaching has long been employed in the Clifton, Ariz., district, and in 1913 some copper was recovered by this method in the Butte district. Experimentation was carried on by numerous companies and there is little doubt that the next few years will witness the construction of several leaching plants. The successful operation of this process on a commercial scale will result in the addition to the reserves of the country of many millions of tons of ore that has not heretofore been considered of commercial grade, besides greatly increasing the recovery from the type of ore now treated and probably recovering much copper from the tailings of earlier operations.

Several of the disseminated deposits contain large bodies of oxidized and partly oxidized ores overlying the sulphide ores, and with a successful method of treatment they will be added to the commercial ore. There will also be important additions from other types of deposits.

Both domestic consumption and export of copper showed increase in 1913 over 1912, and the stocks of refined copper were small at the close of 1913.

It is apparent, however, that during the last few years the producing capacity of the world has increased faster than the consuming capacity, and that if all mines make their greatest possible output a surplus of copper will result. It is almost inevitable, however, that the producing capacity of some of the districts will be restricted on account of unusual conditions prevailing temporarily. The Mexican

output has thus been curtailed for the last two years by unsettled political conditions, and the Lake Superior output was greatly reduced in 1913 by labor conditions. Such conditions can be almost relied upon to keep the output somewhat below the real producing capacity. It seems very doubtful, however, if it will be feasible for all the mines of the world to produce at their maximum capacity for the next few years.

There will be no large producers added in 1914, but those already active will be able to increase the output considerably if there is a demand for the metal. It seems doubtful, however, if the demand will warrant a very large increase in 1914.

GEOLOGIC CLASSIFICATION OF COPPER DEPOSITS.

BASIS OF CLASSIFICATION.

The geologic classification of copper ores is of interest as well as the metallurgical classification. From a statistical standpoint, such a classification is somewhat difficult for the reason that in a single district two or more types may occur and in some instances the amount of copper derived from each has not been recorded. The approximate amount derived from the several types can, however, usually be ascertained.

It is apparent that in a statistical treatment only broad groups can be recognized, as the data are not available for ascertaining the output from types of minor commercial importance, although they may be of great scientific interest.

A classification may be made on the basis of the geologic age of the deposits, which is usually the same for all deposits in a given district, which method groups together deposits differing greatly in mineralogic character and geologic occurrence; or, on the other hand, a classification may be based on geologic occurrence and mineralogic character by which method deposits of widely separated ages are thrown into the same group.

In the following tables is given the production classified according to the geologic age of the deposits and according to geologic occurrence. The basis of these classifications is discussed in the reports for 1910 and 1912.

Classification of production of copper according to geologic age of the deposits.

Age.	Percentage of total.	Percentage in 1912.	Percentage in 1913.
Pre-Cambrian period:			
Lake Superior, Mich.	32.01	21.4	15.6
Jerome, Ariz.			
Encampment, Wyo.			
Paleozoic:			
Ducktown, Tenn.	1.5–2	1.5	1.6
Other Appalachian deposits.			
Mesozoic:			
Shasta County, Cal.	18.45	31.8	36.71
Foothills Belt, Cal.			
Ely, Nev.			
Yerington, Nev.			
Alaska.			
Bisbee, Ariz.			
Globe, Ariz.			
Ray, Ariz.			
Others.			

Classification of production of copper according to geologic age of the deposits—Contd.

Age.	Percentage of total.	Percentage in 1912.	Percentage in 1913.
Tertiary: Butte, Mont.; Morenci-Metcalf, Ariz.; Santa Rita, N. Mex.; Bingham, Utah; Frisco, Utah; Tintic, Utah; Others	46.19	45.3	45.98

Classification of production of copper according to geologic occurrence of the ores.

Character of deposit.	Percentage of total.	Percentage in 1912.	Percentage in 1913.
Lenticular replacements in schistose and igneous rocks: Jerome, Ariz.; Shasta County, Cal.; Foot Hills Belt, Cal.; Ducktown, Tenn.; Prince William Sound, Alaska	8.0	6.9	7.56
Native copper in volcanic rocks: Lake Superior, Mich.	28.4	18.58	12.72
Replacement deposits in sedimentary rocks: Bisbee, Ariz.; Yerington, Nev.; Morenci, Ariz.; Bingham, Utah; Southeast Alaska; Copper River, Alaska; Tintic, Utah; Others	20.6	23.0	24.0
Disseminated deposits: Bingham, Utah; Ely, Nev.; Morenci, Ariz.; Miami, Ariz.; Ray, Ariz.; Santa Rita, N. Mex.	10.0	26.4	32.5
Fissure-vein deposits: Butte, Mont.; Others	33.1	24.8	23.2

PRODUCTION.

SMELTER AND MINE PRODUCTION.

GENERAL STATEMENT.

The production of copper in 1913 by smelters from copper-bearing materials from the United States was 1,224,484,098 pounds, valued at $189,795,035,[1] as compared with 1,243,268,720 pounds, valued at $205,139,338, in 1912, and with 1,097,232,749 pounds, valued at $137,154,092, in 1911. The production for 1913 showed a decrease from the previous year of 18,784,622 pounds, or about 1.5 per cent in quantity and $15,344,303, or 7.43 per cent in value.

[1] For discussion of prices see section on prices on a subsequent page.

The yearly production of copper in the United States from 1845 to 1913, inclusive, together with the actual and relative changes from each preceding year, is shown in the following table:

Magnitude and growth of copper production in the United States from 1845 to 1913, inclusive.

Year.	Production.	Increase.		Average annual increase, by decades.	
	Pounds.	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
1845	224,000				
1846	336,000	112,000	50.0		
1847	672,000	336,000	100.0		
1848	1,120,000	448,000	67.0	246,400	50.0
1849	1,568,000	448,000	40.0		
1850	1,456,000	[a] 112,000	[a] 7.1		
1851	2,016,000	560,000	38.4		
1852	2,464,000	448,000	22.2		
1853	4,480,000	2,016,000	81.8		
1854	5,040,000	560,000	12.5		
1855	6,720,000	1,730,000	33.3		
1856	8,960,000	2,240,000	33.3	1,472,200	28.5
1857	10,752,000	1,792,000	20.0		
1858	12,320,000	1,568,000	14.6		
1859	14,112,000	1,792,000	14.5		
1860	16,128,000	2,016,000	14.3		
1861	16,800,000	672,000	4.1		
1862	21,160,000	4,360,000	26.0		
1863	19,040,000	[a] 2,120,000	[a] 10.0		
1864	17,920,000	[a] 1,120,000	[a] 5.9		
1865	19,040,000	1,120,000	6.3		
1866	19,936,000	896,000	4.7	1,209,600	6.2
1867	22,400,000	2,464,000	12.3		
1868	25,984,000	3,584,000	16.0		
1869	28,000,000	2,016,000	7.7		
1870	28,224,000	224,000	.8		
1871	29,120,000	896,000	3.2		
1872	28,000,000	[a] 1,120,000	[a] 3.8		
1873	34,720,000	6,720,000	24.0		
1874	39,200,000	4,480,000	12.9		
1875	40,320,000	1,120,000	2.9		
1876	42,560,000	2,240,000	5.6	3,225,600	8.2
1877	47,040,000	4,480,000	10.0		
1878	48,160,000	1,120,000	2.4		
1879	51,520,000	3,360,000	7.0		
1880	60,480,000	8,960,000	17.4		
1881	71,680,000	11,200,000	18.5		
1882	90,646,232	8,966,232	12.5		
1883	115,526,053	24,886,221	27.4		
1884	144,946,653	29,420,600	25.5		
1885	165,875,766	20,929,113	14.4		
1886	156,735,381	[a] 9,140,385	[a] 5.5	18,928,949	14.8
1887	180,920,524	24,185,143	15.4		
1888	226,361,466	45,440,942	25.0		
1889	226,775,962	414,496	.2		
1890	259,763,092	32,987,130	14.5		
1891	284,121,764	24,358,672	9.4		
1892	344,998,679	60,876,915	21.4		
1893	329,354,398	[a] 15,644,281	[a] 4.5		
1894	354,188,374	24,833,976	7.5		
1895	380,613,404	26,425,030	7.4		
1896	460,061,430	79,448,026	20.0	34,635,407	9.4
1897	494,078,274	34,016,844	7.4		
1898	526,512,987	32,434,713	6.6		
1899	568,666,921	42,153,934	8.0		
1900	606,117,166	37,450,245	6.6		
1901	602,072,519	[a] 4,044,647	[a] .7		
1902	659,508,644	57,436,125	9.5		
1903	698,044,517	38,535,873	5.8		
1904	812,537,267	114,492,750	16.4		
1905	888,784,267	76,247,000	11.0		
1906	917,805,682	15,897,839	1.7	47,404,234	6.1
1907	868,996,491	[a] 48,809,191	[a] 5.3		
1908	942,570,721	73,074,230	8.4		
1909	1,092,951,624	150,380,903	15.9		
1910	1,080,159,509	[a] 12,792,115	[a] 1.2		
1911	1,097,232,749	17,073,240	1.6		
1912	1,243,268,720	146,035,971	13.3		
1913	1,224,484,098	18,784,622	1.5		
Total	18,857,476,910				

[a] Decrease.

The figures, except for 1913, are taken from the previous volumes of Mineral Resources of the United States. Statistics from 1882 to 1913, inclusive, are based on the returns to the United States Geological Survey by the copper-producing companies. Figures for the years prior to 1882 were compiled by the Survey from the best sources available. Reliable figures for years previous to 1845 are not obtainable. The year 1845, however, marks the entrance of the Lake Superior district into the ranks of producers and is really the beginning of important production of copper in this country. The industry has shown a steady and, since 1880 when Arizona and Montana became important producers, a very rapid growth.

Only six times since 1880 has the annual production shown a decrease from that of the preceding year and in every instance the decrease has been slight and has been more than recovered the following year. The years showing a decrease are 1886, 1893, 1901, 1907, 1910, and 1913. At several other times the increase has been slight. In most years when there has been a decrease it may be attributed to a general condition of financial and business depression, which has resulted in a decrease in the demand for copper and other materials necessary to the expansion of industries. In three years a slight decrease appears to have been due to the fact that the producing capacity of the country had been increased out of proportion to the demand for domestic consumption and export, and a temporary curtailment in production became necessary to permit the absorption of accumulated stocks. This, coupled with attempts at artificial control of prices, appears to have been the case in 1886 and also in 1901, and the decrease in production in 1910 may be attributed to a similar cause. The large increase in 1912 which, with one exception, that of 1909, was the largest in the history of the industry, was due to the output from mines that have reached the producing stage during 1912 or had previously made but relatively small production.

The decrease in 1913 is more than equaled by the falling off in Michigan due to labor troubles. Montana also showed a notable decrease, which was more than made up by notable increases in Arizona, New Mexico, and Utah.

So far as the producing capacity of the country is concerned, a substantial increase is possible for 1914, though the Michigan output for that year will be considerably below normal. Whether or not such an increase is made, depends on the demand for domestic consumption and export.

SMELTER RETURNS.

The figures of smelter production for 1913 are based on returns made confidentially to the United States Geological Survey by all known smelting companies handling copper-bearing materials from the United States. To all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries to secure the accurate distribution of the output sincere thanks are extended. The following list gives the names of the owning or operating companies, the location, and the final copper product of smelting and refining plants treating material from the

United States during 1913. It does not include lead and zinc plants that recovered copper as a by-product from mixed ores. Lists of lead and zinc smelters can be found in the reports on those metals.

Copper smelting plants that treated materials from the United States in 1913.

Location.	Company.	Final copper product.
UNITED STATES.		
Arizona:		
Clifton	Arizona Copper Co	Blister.
Do	Shannon Copper Co	Do.
Douglas	Calumet & Arizona Mining Co	Do.
Do	Copper Queen Consolidated Mining Co	Do.
Globe	Old Dominion Copper Mining & Smelting Co.	Do.
Hayden	American Smelting & Refining Co	Do.
Humboldt	Consolidated Arizona Smelting Co	Do.
Jerome	United Verde Copper Co	Do.
Morenci	Detroit Copper Mining Co	Do.
Swansea	Swansea Consolidated Gold & Copper Co	Do.
Tucson	Pioneer Smelting Co	Matte.
California:		
Campo Seco	Penn Mining Co	Do.
Kennett	Mammoth Copper Mining Co	Blister.
Martinez	Mountain Copper Co	Do.
Needles	Needles Smelting & Refining Co	Matte.
Colorado:		
Ouray	Brown Mountain Smelting Co	Do.
Salida	Ohio & Colorado Smelting & Refining Co	Do.
Idaho:		
Ivers	Lost Packer Mining Co	Do.
Maryland: Baltimore	Baltimore Copper Smelting & Rolling Co	Electrolytic.
Michigan:		
Hancock	Lake Superior Smelting Co	Anodes and lake.
Do	Quincy Mining Co	Do.
Houghton	Michigan Smelting Co	Do.
Hubbell	Calumet & Hecla Mining Co	Do.
Montana:		
Anaconda	Anaconda Copper Mining Co	Blister.
Butte	East Butte Copper Mining Co	Do.
Great Falls	Anaconda Copper Mining Co	Blister and electrolytic.
Nebraska: Omaha	American Smelting & Refining Co	Blister.
Nevada:		
Wabuska	Mason Valley Mines Co	Matte.
McGill	Nevada Consolidated Copper Co	Blister.
New Jersey[a]		
Chrome	United States Metals Refining Co	Electrolytic and casting.
Maurer	American Smelting & Refining Co	Electrolytic.
Newark	Balbach Smelting & Refining Co	Electrolytic and casting.
Perth Amboy	Raritan Copper Works	Electrolytic.
New Mexico: San Pedro	Santa Fe Gold & Copper Mining Co	Matte.
New York:		
Black Rock	Buffalo Smelting Works	Lake and electrolytic.
Laurel Hill	Nichols Copper Co	Electrolytic and casting.
Tennessee:		
Copperhill	Tennessee Copper Co	Blister.
Isabella	Ducktown Sulphur, Copper & Iron Co. (Ltd.)	Matte.
Texas: El Paso	American Smelting & Refining Co	Blister.
Utah:		
Garfield	Garfield Smelting Co	Do.
International	International Smelting & Refining Co	Do.
Virginia: West Norfolk	Virginia Smelting Co	Matte.
Washington: Tacoma	Tacoma Smelting Co	Blister and electrolytic.
CANADA.		
British Columbia:		
Grand Forks	Granby Consolidated Mining, Smelting & Power Co.	Blister.
Greenwood	British Columbia Copper Co. (Ltd.)	Do.
Trail	Consolidated Mining & Smelting Co. of Canada.	Matte.
MEXICO.		
Aguas Calientes:		
Aguas Calientes	American Smelting & Refining Co	Blister.
Cananea	Cananea Consolidated Copper Co	Do.

[a] This list does not include a smelter in New Jersey and one in Pennsylvania, both of which make blister from material solely of foreign origin.

During the year 46 copper smelting and refining plants treated material from the United States. Of these, 41 were domestic plants and 5 were foreign—3 located in British Columbia and 2 in Mexico.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of furnace-refined copper and copper cast into anodes for electrolytic refining. In the case of blister copper the figures represent the fine copper content. Some casting copper is produced direct from ore and matte and this is included in the smelter production.

The following table shows approximately the production of blister copper from different sections. Smelters that produced only matte are not included in this distribution:

Production of copper in 1913, apportioned according to locality in which smelted to blister, in pounds.

Locality.	Domestic.	Foreign.	Total.
Arizona and Texas	420,200,000	.....	.....
Montana	285,000,000	.....	.....
Utah and Nevada	234,900,000	.....	.....
California and Washington	54,000,000	.....	.....
All others	197,000,000	.....	.....
Total by domestic plants	1,191,100,000	[a] 109,492,000	1,300,592,000
Total by foreign plants from domestic ore, concentrates, and matte	33,300,000	.....	.....
Grand total from domestic ores	1,224,400,000	.....	.....

[a] Imports reported by Bureau of Foreign and Domestic Commerce, Department of Commerce.

As will be seen by comparing this table with the table showing the production by States and districts, ore, with few exceptions, is reduced to blister copper before being shipped from the district. The exceptions in the case of important producing States are Michigan and Colorado. In the case of Michigan the shipping product is high-grade concentrate transported by Lake boats to Buffalo at a low cost; in the case of Colorado the copper is largely produced as lead furnace matte and is shipped to Omaha for further treatment. Considerable matte produced in California is shipped east for conversion.

MINE RETURNS.

The figures of mine production are based on reports furnished to the United States Geological Survey by all mines producing copper in 1913. These mines reported 1,235,569,727 pounds of copper, or 11,085,629 pounds more than the smelters. The mines and smelters of several of the large copper producers are under the same management, and their production is reported on the same basis. In the case of mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion there is likely to be considerable discrepancy, as the mines may report a considerable quantity that has not reached the stage of blister by the close of the year and is consequently not included in the smelter production, or material that was reported by the mines in one year may be treated by the smelters the following year. This discrepancy is more pro-

nounced if a marked curtailment of production occurs at the beginning or at the close of the year, so that there is not the balance of overlap that occurs if the industry is in normal condition throughout the year. A number of operators report the copper in their ores and concentrates on the basis of assay content, in which case it exceeds the smelter recovery from the same material by the quantity lost in smelting. Considerable copper is recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for, and, consequently, is not always reported by the mines.

The following table shows the output of copper from domestic ores for the last eight years as reported by mines, smelters, and refineries:

Production of copper from domestic ores as reported by the mines, the smelters, and the refineries, 1906–1913, in pounds.

Year.	Mine.	Smelter.	Refinery.
1906	916,971,387	917,805,682	887,682,387
1907	847,151,015	868,996,491	784,271,427
1908	956,840,578	942,570,721	919,111,414
1909	1,126,521,126	1,092,951,624	1,065,564,921
1910	1,088,237,432	1,080,159,509	1,071,894,876
1911	1,114,764,197	1,097,232,749	1,101,270,803
1912	1,249,094,891	1,243,268,720	1,203,676,895
1913	1,235,569,727	1,224,484,098	1,236,823,913
Total	8,535,150,353	8,467,469,594	8,270,296,6'6

The difference between the smelter and the refinery production is accounted for entirely by an increase in the stocks of blister copper plus the copper content of bluestone produced and the loss in refining.

It appears that although theoretically the output reported by the mines should be considerably in excess of that reported by the smelters, this difference in the last eight years has been nearly balanced by the copper recovered from lead, zinc, gold, silver, and sulphur ores which carry copper values so low that they are not paid for and consequently have not usually been reported by the mines.

PRODUCTION BY STATES.

Twenty-four States and Territories contributed to the copper production of 1913. The following table shows the mine and the smelter output of individual States for 1912 and 1913.

According to smelter returns, the three leading States, Arizona, Montana, and Michigan, produced 69 per cent of the total output of 1913; the same States produced 72 per cent of the output in 1912; and the eight leading States, including Utah, Nevada, Alaska, California, and New Mexico, produced over 96.78 per cent of the total output in 1913.

Production of copper by smelter returns in 1912 and 1913, compared with mine returns for same years, by States, in pounds.

State.	Production.					
	1913				1912	
	Rank.	Percentage of total.	Smelter returns.	Mine returns.	Smelter returns.	Mine returns.
Alaska	8	1.91	23,423,070	21,659,958	31,926,209	29,230,491
Arizona	1	33.02	404,278,809	407,923,402	359,322,096	365,038,649
California	7	2.65	32,492,265	34,575,007	31,516,471	33,451,672
Colorado	10	.74	9,052,104	7,727,826	7,963,520	7,107,303
Idaho	11	.71	8,711,490	9,592,966	7,182,185	7,492,152
Maryland	25	.....	.....	(a)	53,043	(a)
Michigan	3	12.72	155,715,286	135,853,409	231,112,228	218,138,408
Missouri	13	.05	576,204	576,204	440,725	440,725
Montana	2	23.33	285,719,918	287,828,699	308,770,826	309,738,873
Nevada	5	6.96	85,209,536	90,693,751	83,413,900	86,477,494
New Mexico	6	4.10	50,196,881	56,308,706	29,170,400	34,030,964
North Carolina	22	.....	180	.....	63,766	75,915
Oklahoma	24	.....	11	.....	.....	.....
Oregon	16	.....	77,812	43,330	311,860	260,429
Pennsylvania	15	.02	245,337	a 503,792	248,378	a 594,022
Philippine Islands	23	.....	22	.....	.....	.....
South Dakota	21	.....	4,549	1,793	23,657	.....
Tennessee	9	1.59	19,489,654	19,390,750	18,395,256	18,483,173
Texas	19	.....	39,008	34,665	964	721
Utah	4	12.09	148,057,450	161,445,962	132,150,052	137,307,485
Vermont	20	.....	5,771	13,900	.....	.....
Virginia	17	.....	46,961	56,287	96,753	112,835
Washington	12	.06	732,742	954,081	1,069,938	1,086,010
Wyoming	14	.03	362,235	385,239	25,080	27,570
Unapportioned	18	.....	46,803	.....	11,413	.....
Total	.....	.....	1,224,484,098	1,235,569,727	1,243,268,720	1,249,094,891

a Pennsylvania and Maryland combined.

In the distribution of the blister output to the States of origin it is necessary to have reports not only from blister producers but also from matte smelters, as the matte is credited by the smelter that converts it to the State from which it was received, although the matte smelter may have received its ores from several States. In the adjustment of the products of these matte smelters slight errors in the distribution of the blister production are probably introduced.

The following table shows the production from 1904 to 1913 for each State for which separate statistics are available.

In the report for 1910 the annual production by States since 1845 is given. This report can be procured on application to the Director of the United States Geological Survey, Washington, D. C.

Production of copper in the United States, 1904–1913, by States, in pounds.

State.	1904	1905	1906	1907	1908
Alaska	2,043,586	4,900,866	8,685,646	7,034,763	4,438,836
Arizona	191,602,958	226,854,461	262,566,103	256,778,437	289,523,267
California	28,529,023	16,697,489	28,153,202	33,696,602	39,643,835
Colorado	9,506,944	9,404,830	7,427,253	13,998,496	13,943,878
Idaho	2,158,858	7,321,585	8,578,046	9,707,299	7,256,086
Michigan	208,309,130	230,287,992	229,695,730	219,131,503	222,289,584
Montana	298,314,804	314,750,582	294,701,252	224,263,789	252,503,651
New Mexico	5,368,666	5,334,192	7,099,842	10,140,140	4,991,351
Nevada	.....	413,292	1,090,635	1,998,164	12,241,372
Oregon	.....	846,615	545,859	518,694	271,191
South Dakota	100,000	38	.....	.....	5,471
Utah	47,062,889	54,083,506	50,329,119	66,418,370	71,370,370

Production of copper in the United States, 1904–1913, by States, in pounds—Continued.

State.	1904	1905	1906	1907	1908
Washington	663,694	223,328	290,823	122,263	162,201
Wyoming	3,565,629	2,530,531	106,177	3,026,004	2,416,197
Eastern States					
Southern States	15,211,086	15,134,960			
Middle States					
Eastern States and unapportioned			18,535,995	22,161,967	21,513,431
Lead desilverizers and unapportioned	[a] 100,000				
Total	812,537,267	888,784,267	917,805,682	868,996,491	942,570,721

State.	1909	1910	1911	1912	1913
Alaska	4,057,142	4,311,026	22,314,889	31,926,209	23,423,070
Arizona	291,110,298	297,250,538	303,202,532	359,322,096	404,278,809
California	53,568,708	45,760,200	35,835,651	31,516,471	32,492,265
Colorado	11,485,631	9,307,497	9,791,861	7,963,520	9,052,404
Idaho	7,096,132	6,877,515	4,514,116	7,182,185	8,711,490
Michigan	227,005,923	221,462,984	218,185,236	231,112,228	155,715,286
Montana	314,858,291	283,078,473	271,814,491	308,770,826	285,719,918
New Mexico	5,031,136	3,784,609	2,860,400	29,170,400	50,196,881
Nevada	53,849,281	64,494,640	65,561,015	83,413,900	85,209,536
Oregon	245,403	22,022	125,943	311,860	77,812
South Dakota	41,988	43	1,607	23,657	4,549
Utah	101,241,114	125,185,455	142,340,215	132,150,052	148,057,450
Washington	120,611	65,021	195,503	1,069,938	732,742
Wyoming	433,672	217,127	130,499	25,080	362,235
Eastern States and unapportioned	22,806,294	18,342,359	20,358,791	19,310,298	20,449,951
Total	1,092,951,624	1,080,159,509	1,097,232,749	1,243,268,720	1,224,484,098

[a] Based partly on estimates.

Total production of copper by States, 1845–1913, and percentage and rank of each State.

	Quantity.	Percentage.	Rank.
	Pounds.		
Alaska	114,475,623	0.61	10
Arizona	4,266,987,705	22.63	3
California	544,979,344	2.89	5
Colorado	230,559,548	1.22	8
Idaho	74,965,475	.40	11
Michigan	5,361,432,892	28.43	2
Montana	6,192,744,628	32.84	1
New Mexico	174,550,844	.93	9
Nevada	372,123,548	1.98	7
Oregon	2,965,399	.01	15
South Dakota	5,283,626	.03	13
Utah	1,081,322,177	5.73	4
Washington	3,975,964	.02	14
Wyoming	26,361,214	.14	12
Eastern States and unapportioned	404,748,923	2.14	6
Total	18,857,476,910	100.00	

The totals in the preceding table show the copper output of each important copper-producing State, except those on the Atlantic coast since the beginning of the industry. Some copper was produced in New Mexico in the early years of the last century, but the exact quantity is not known. It was not large as measured by present production of the metal. A little copper was also produced in Michigan prior to 1845, but it was not sufficient in quantity to be of importance. Considerable copper was produced in the Eastern States prior to 1845.

Under "Eastern States and unapportioned" is included some copper classed as "lead desilverizers, etc.," in the earlier reports of the Survey. This should properly be credited to some of the Western States. The output of the Central States, except Michigan, is also included under this head. Statistics for the individual Eastern States have not been compiled, but it may be stated that approximately 278,500,000 pounds has been derived from Tennessee. Of the remainder, Vermont and Virginia have made the largest contributions, and some copper has been produced by practically all of the Appalachian States.

It will be noted that Montana, Michigan, and Arizona stand out as the three great copper-producing States. Montana ranks first, with nearly one-third of the entire output of the country; Michigan ranks second, with more than 28 per cent; and Arizona ranks third with over one-fifth of the total output. Utah, ranking next in order, has produced about one-twentieth of the total output. The three leading States have produced 84 per cent of the entire production.

It will be noted by reference to the table showing the output for 1913 that these three States still maintain their preeminence, producing 81 per cent of the total output in 1908, 76 per cent in 1909, 74 per cent in 1910, and 72 per cent in 1911 and 1912, and 69 per cent in 1913. The relative importance of other States, however, is much greater in recent years, Utah producing 12 per cent of the total output in 1913.

In the following table is given the blister copper output of the leading districts of the country in 1913:

Blister copper production of principal districts in 1913, in pounds.

District or region.	State.	Approximate smelter output.	Percentage of total production.	Rank.
Butte	Montana	283,600,000	23.16	1
Lake Superior	Michigan	155,715,000	12.72	2
Bisbee	Arizona	155,100,000	12.67	3
Bingham	Utah	132,000,000	10.78	4
Globe	Arizona	71,000,000	5.80	5
Morenci-Metcalf	do	70,100,000	5.72	6
Ely	Nevada	68,600,000	5.60	7
Mineral Creek (Ray)	Arizona	52,340,000	4.27	8
Santa Rita	New Mexico	50,511,000	4.13	9
Jerome	Arizona	35,300,000	2.88	10
Shasta County	California	26,800,000	2.19	11
Alaska (all districts)		23,423,000	1.91	12
Ducktown	Tennessee	19,489,000	1.59	13
Yerington	Nevada	14,400,000	1.18	14
Tintic	Utah	9,250,000	.76	15
Courtland	Arizona	6,200,000	.51	16
Calaveras County	California	5,800,000	.47	17
Coeur d'Alene	Idaho	4,500,000	.37	18
Alder Creek	do	3,900,000	.32	19
Frisco	Utah	3,000,000	.25	20
Palmetto	Arizona	2,995,000	.24	21
Big Bug	do	2,000,000	.16	22
Leadville	Colorado	1,920,000	.16	23
San Juan-Ouray	do	1,720,000	.14	24
Lordsburg	New Mexico	1,600,000	.13	25
Pioneer	Arizona	1,408,000	.11	26
Ophir	Utah	1,400,000	.11	27
Uinta Summit (Park City)	do	1,300,000	.11	28
Pima	Arizona	1,217,000	.10	29
Copper Basin	do	1,188,000	.10	30
Total		1,207,776,000	98.64	
All others		16,708,000	1.36	
Grand total		1,224,484,000	100.00	

As shown in this table, 30 districts in 1913 each produced 1,000,000 or more pounds of blister copper.

The following table shows the output of the principal copper-producing districts of the United States from the beginning of production to the close of 1913. For the later years the statistics are compiled from reports furnished to the United States Geological Survey by the producing companies. For the earlier years the figures are taken mainly from reports on the several districts by members of the Survey.

Total blister copper production of principal districts to the close of 1913, in pounds, and percentage of total and rank of each.

District.	State.	Production began—	Quantity.	Percentage of total production.	Rank.
Butte	Montana	1868	6,177,800,000	32.76	1
Lake Superior	Michigan	1845	5,360,995,000	28.43	2
Bisbee	Arizona	1880	1,710,300,000	9.07	3
Morenci-Metcalf	do	1873	1,104,200,000	5.86	4
Bingham	Utah	1896	834,500,000	4.43	5
Jerome	Arizona	1883	670,180,000	3.56	6
Globe	do	1881	511,900,000	2.72	7
Shasta County	California	1897	418,700,000	2.23	8
Ely	Nevada	1908	325,900,000	1.73	9
Ducktown	Tennessee	1850	268,544,000	1.43	10
Santa Rita	New Mexico	1800(?)	179,911,000	.91	11
Foothills Belt	California	1862	121,300,000	.64	12
Tintic	Utah	1880(?)	113,150,000	.61	13
Mineral Creek (Ray)	Arizona		102,640,000	.54	14
Total			17,900,020,000	94.92	
All others			957,456,000	5.08	
Grand total			18,857,476,000	100.00	

Fourteen districts situated in eight States have each contributed in excess of 100,000,000 pounds to the copper output of the country. Five of these districts are in Arizona, two each in California and Utah, and one each in Montana, Michigan, Nevada, New Mexico, and Tennessee. Two districts stand out prominently. They are the Butte district, Mont., which has contributed nearly one-third of the output of the country, and the Lake Superior district, Mich., which has produced over 28 per cent of the total output. Bisbee, ranking third, has yielded 9.07 per cent of the total production. The 14 districts have yielded 94.92 per cent of the total output of the United States since 1845.

It will be seen by a comparison of the table showing the total output of the leading districts with the table showing the output of the leading districts in 1913 that the first five are the same, but that the order is changed to some extent.

It is noteworthy that there is not a single instance where one of the leading copper districts of the United States, several of which have been active producers for a period of 30 years or more, has been worked out or showed a decrease in its ability to produce copper.

TONNAGE AND YIELD OF COPPER ORES.

COPPER-BEARING ORES PRODUCED IN 1913.

The following tables show the tonnage and the yield in copper of the ore produced by the mines of the United States in 1913. The figures are taken from the mine reports referred to in the prefatory note, which form a part of the volume on Mineral Resources issued annually by the United States Geological Survey. The close agreement between the output as reported by the mines and the actual recovery of metal by the smelters indicates that the tenor of ores as reported by the mines is very close to the actual recovery of metal. The classification of some of the complex western ores is a difficult and more or less arbitrary matter. Under copper ores are classed those which contain 2½ per cent or more of copper, as well as those which contain less than this percentage, provided their principal value is in copper. Under copper-lead and copper-zinc ores are classed complex ores in which copper is an important constituent. Considerable copper was reported by the mines from ores mined primarily for other metals, including siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for values in other metals. No attempt has been made to compile tables showing the tonnage and yield of this group of copper-bearing ores, but together with old slags, etc., they have yielded a total of 22,321,897 pounds of copper.

Copper produced in 1913 from ores in which copper constitutes the principal value, by States.

State.	Copper ore.	Copper in ore.	Per-centage.	Gold in ore.	Silver in ore.	Value in gold and silver per ton.
	Short tons.	*Pounds.*		*Fine ounces.*	*Fine ounces.*	
Alaska	135,756	21,659,958	7.98	6,385.50	273,179	$2.19
Arizona	7,553,935	405,963,634	2.69	64,437.34	2,885,115	.41
California	448,439	33,975,606	3.79	14,219.65	833,672	1.84
Colorado	16,555	1,701,666	5.17	7,615.92	223,108	17.65
Idaho	143,865	8,823,011	2.57	5,032.26	414,371	2.46
Michigan	7,016,370	135,853,409	.97	.....	295,173	.025
Missouri	461	69,757	7.57	.....	176	.23
Montana	5,335,851	286,393,731	2.68	32,084.86	10,311,807	1.29
Nevada	3,698,255	90,117,754	1.22	39,109.98	241,756	.26
New Mexico	2,006,014	55,334,759	1.38	4,697.38	197,574	.11
Oregon	122	32,558	13.34	99.99	154	17.70
Pennsylvania and Maryland	239,083	503,792	.16	.....	.....	.....
Tennessee	652,253	19,390,750	1.49	367.41	108,105	.112
Texas	314	34,178	5.45	1.65	9,605	18.58
Utah	9,070,740	152,137,467	.838	32,830.03	2,314,348	.38
Vermont	95	13,900	7.31	.14	105	.70
Virginia	877	56,287	3.21	24.04	960	1.23
Washington	16,733	800,374	2.39	158.48	140,214	5.26
Wyoming	964	385,239	20.00	.....	831	.52
Total and average	36,336,682	1,213,247,830	1.67	207,064.63	18,250,253	.42

Copper ores concentrated and smelted, concentrates produced, and copper produced from each class of ore in 1913, by States.

State.	Ore concentrated.				Ore smelted.		
	Quantity.	Concentrates produced.	Copper in concentrates.	Percentage of copper from ore.	Quantity.	Copper produced.	Percentage of copper from ore.
	Short tons.	*Short tons.*	*Pounds.*		*Short tons.*	*Pounds.*	
Alaska	54,895	11,000	14,621,834	13.31	80,861	7,038,124	4.35
Arizona	5,226,497	435,389	147,262,544	1.41	2,327,438	253,977,607	5.45
California	96	11	7,310	3.80	448,343	33,968,296	3.79
Colorado	84	27	2,037	1.20	16,471	1,699,629	5.10
Idaho	76,548	5,482	2,235,836	1.46	67,317	6,587,175	4.89
Michigan	7,016,370	107,077	135,853,409	.97			
Missouri					461	69,757	7.57
Montana	4,643,150	1,421,566	205,049,757	2.21	692,701	72,306,004	5.22
Nevada	3,428,346	480,116	70,040,693	1.02	269,909	20,077,061	3.72
New Mexico	1,942,700	183,116	51,575,040	1.33	63,314	3,759,719	2.97
Oregon					122	32,558	13.34
Pennsylvania and Maryland	239,083	7,322	503,792	.16			
Tennessee					652,253	19,390,750	1.49
Texas					314	34,178	5.45
Utah	8,407,848	382,663	126,364,491	.75	662,892	25,719,652	1.94
Vermont					95	13,900	7.31
Virginia					877	56,287	3.21
Washington	10,755	1,101	208,322	.97	5,978	592,054	4.45
Wyoming					964	385,239	20.00
Total and average	31,046,372	3,034,870	753,725,065	1.22	5,290,310	445,707,990	4.22

Copper produced from copper-lead and copper-zinc ores in 1913, by States.

State.	Copper-lead and copper-zinc ores.	Copper in ore.	Percentage of copper.
	Short tons.	*Pounds.*	
Arizona	7,834	322,877	2.06
Colorado	6,417	640,795	5.00
Idaho			
Montana	1,054	64,083	3.04
Nevada	6,197	418,886	3.38
New Mexico	103	7,898	3.83
Texas	20	1,298	3.25
Utah	2,794	254,773	4.56
Total and average	24,419	1,710,610	3.51

Copper derived from ore classed as copper-bearing ores (copper, copper-lead, and copper-zinc ores), and total production of copper from all sources in 1913, by States.

State.	Ore treated.	Copper recovered.	Percentage of copper.	Copper from all sources, including old slags, smelter cleanings, precipitates, etc.
Alaska	135,756	21,659,958	7.98	21,659,958
Arizona	7,561,769	406,286,511	2.69	[a] 407,923,402
California	448,439	33,975,606	3.79	34,575,007
Colorado	22,972	2,342,461	5.10	[b] 7,727,826
Idaho	143,865	8,823,011	2.57	9,592,966
Michigan	7,016,370	135,853,409	.97	135,853,409
Missouri	461	69,757	7.57	[c] 576,204
Montana	5,336,905	286,457,814	2.68	[d] 287,828,699
Nevada	3,704,452	90,536,640	1.21	[e] 90,693,751
New Mexico	2,006,117	55,342,657	1.37	56,308,706
Oregon	142	33,856	11.94	43,330
Pennsylvania and Maryland	239,083	503,792	.16	503,792
South Dakota	.....	.....	.....	1,793
Tennessee	652,253	19,390,750	1.49	19,390,750
Texas	314	34,178	5.45	34,665
Utah	9,073,534	152,392,240	.84	[f] 161,445,962
Vermont	95	13,900	7.31	13,900
Virginia	877	56,287	5.21	56,287
Washington	16,733	800,374	2.39	954,081
Wyoming	964	385,239	20.00	385,239
Total and average	36,361,101	1,214,948,440	1.67	1,235,569,727

[a] Considerable copper was recovered from old slags and ores not classed as copper ores.
[b] Most of the copper from Colorado is derived from ores classed as siliceous ores and lead ores.
[c] Mainly recovered in dressing lead ores.
[d] Considerable copper was recovered as precipitates from mine waters and from ores not classed as copper ores.
[e] Considerable copper was recovered from siliceous and other ores.
[f] A large amount of copper was derived from ores classed as lead ores, lead-zinc ores, and siliceous ores.

Copper ores produced in the United States, 1906–1913, by years, in short tons, and average yield in copper, gold, and silver.

Year.	Copper ores.	Yield in copper.	Yield per ton in gold.	Yield per ton in silver.	Value per ton in gold and silver.
	Short tons.	*Per cent.*	*Ounces.*	*Ounces.*	
1906	18,000,000	2.50	0.0150	0.882	$0.856
1907	20,253,000	2.11	.0135	.609	.682
1908	22,290,886	2.07	.0104	.666	.560
1909	27,932,618	1.98	.0097	.655	.540
1910	28,497,238	1.88	.0093	.562	.495
1911	29,988,235	1.82	.0089	.555	.492
1912	35,656,414	1.71	.0073	.517	.468
1913	36,336,682	1.67	.0057	.502	.420

Copper ores produced in the United States, 1906–1913, by years, classified as smelting and concentrating ores, in short tons, and average yield in copper from each.

Year.	Smelting ores.		Concentrating ores.	
	Quantity.	Yield in copper.	Quantity.	Yield in copper.
	Short tons.	*Per cent.*	*Short tons*	*Per cent.*
1906	3,278,000	.....	14,722,000	.....
1907	3,957,500	4.05	16,295,500	1.41
1908	4,665,534	4.27	17,760,522	1.485
1909	5,267,707	4.15	22,664,911	1.47
1910	5,001,394	4.14	23,495,844	1.40
1911	4,355,650	4.66	25,632,585	1.34
1912	5,014,018	4.45	30,642,396	1.26
1913	5,290,310	4.22	31,046,372	1.22

TONNAGE.

The output of copper, copper-lead, and copper-zinc ores mined in 1913 was 36,361,101 tons, as compared with 35,671,028 tons in 1912. Of this output 36,336,682 tons were copper ores and 24,419 tons were copper-lead and copper-zinc ores, as compared with 35,656,414 tons of copper ores and 14,614 tons of copper-lead and copper-zinc ores in 1912. Of the 36,336,682 tons of copper ores, 5,290,310 tons were smelting ores and 31,046,372 tons were concentrating ores, as compared with 5,014,018 tons of smelting ores and 30,642,396 tons of concentrating ores in 1912.

In 1913 concentrating ores produced 3,034,870 tons of concentrates, the average concentration being 10.23 into 1, as compared with 11.14 into 1 in 1912, and with 11.6 into 1 in 1911. Excluding the ores and concentrates from Michigan, 24,030,002 tons of ore produced 2,927,793 tons of concentrates, or a concentration of about 8.2 into 1, as compared with 7.5 into 1 for 1912.

It is seen by reference to the tables showing the production of ores for the last eight years that there has been an increase of about 100 per cent in the tonnage mined since 1906. The actual increase has been mainly in concentrating ores. The output of smelting ores has increased about 61 per cent and that of concentrating ores has increased about 110 per cent. Utah, with 9,070,740 tons, was the largest producer of copper ores in 1913, and was followed in order by Arizona, Michigan, Montana, Nevada, New Mexico, Tennessee, and California. In the output of smelting ores the States were in the following order: Arizona, Montana, Utah, Tennessee, and California; in the output of concentrating ores Utah was first, followed in order by Michigan, Montana, Arizona, Nevada, and New Mexico.

YIELD.

The 36,361,101 tons of copper, copper-lead, and copper-zinc ores mined in 1913 contained 1,214,948,440 pounds of copper, or an average of 1.67 per cent, as compared with 1.70 per cent for 1912. If the Michigan output be excluded, the yield of the remaining copper ores was 1.84 per cent in 1913, as compared with 2.06 per cent in 1912 and with 2.30 per cent in 1911.

In 1913 a total of 36,336,682 tons of copper ores produced 1,213,247,830 pounds of copper, or an average yield of 1.67 per cent copper, and 24,419 tons of copper-lead and copper-zinc ores produced 1,710,610 pounds, or an average yield of 3.51 per cent copper. The 5,290,310 tons of smelting ore yielded 445,707,990 pounds of copper, or an average of 4.22 per cent, as compared with 4.45 per cent in 1912 and with 4.66 per cent for 1911.

The 31,046,372 tons of concentrating ore yielded 753,725,065 pounds of copper, or an average of 1.22 per cent, as compared with 1.26 per cent for 1912. Excluding the ores from Michigan, which yielded an average of 0.97 per cent in 1913, the concentrating ores from the remainder of the United States yielded an average of 1.29 per cent, as compared with 1.41 per cent in 1912.

As shown in the table giving yield in copper, gold, and silver, there has been a marked decrease in the tenor of copper ores treated during the last eight years, the average yield dropping from 2.50 per cent in

1906 to 1.67 per cent in 1913. The average yield of the smelting and the concentrating ores, considered separately, shows less change, the decrease in the average of total ores being due in part to a relative increase in the tonnage of concentrating ores.

Of the important copper-producing States Alaska yielded the highest grade of ore in 1913, the average yield being 7.98 per cent copper; California was second, with 3.79 per cent; Arizona was third, with 2.69 per cent; Montana was fourth, with 2.68 per cent; and Tennessee, Nevada, New Mexico, and Utah followed in the order named.

Of the States producing an important quantity of smelting ore Arizona had the highest yield with 5.45 per cent, followed by Montana with 5.22 per cent, Alaska with 4.35 per cent, California with 3.79 per cent, and Utah and Tennessee with 1.94 and 1.49 per cent, respectively.

In the yield from concentrating ores Montana took first rank, with an average of 2.21 per cent, followed by Arizona, with 1.41 per cent; New Mexico, 1.33 per cent; Nevada, 1.02 per cent; Michigan, 0.97 per cent; and Utah, 0.75 per cent.

Unusually high-grade ores were concentrated in Alaska, averaging 13.31 per cent.

Since 1908 the average recovery from concentrating ores has decreased from 1.48 per cent to 1.22 per cent.

In 1913 copper ores yielded 207,064.63 ounces of gold and 18,250,253 ounces of silver, or an average of 0.0057 ounce of gold and 0.502 ounce of silver per ton. The total value of the gold and silver content of copper ores was $15,303,559, an average precious-metal value of 42 cents per ton. In 1912 copper ores yielded 0.0073 ounce of gold and 0.517 ounce of silver per ton, an average precious-metal value of 46.8 cents per ton. Exclusive of that portion of the Michigan ores from which the silver was not recovered, the average precious-metal content in 1913 was 49 cents per ton of ore, as compared with 62 cents in 1912 and with 67 cents in 1911.

Exclusive of the Michigan ores that did not yield silver, there was still included considerable ore from which the gold and silver values were not recovered, namely, that producing the casting copper from the Morenci Metcalf district, Arizona, and to a slight extent from other districts. This casting copper was not electrolytically refined, and consequently the precious-metal values were not recovered from it.

Among the important copper-producing States Alaska was first in the yield of gold and silver per ton of copper ore, the average being $2.19; California was second, with $1.84; Montana third, with $1.42; Arizona, with $0.41; Utah, with $0.38; Nevada, with $0.26; New Mexico, with $0.11; Tennessee, with $0.11; and Michigan, with $0.025.

REVIEW BY STATES.

INTRODUCTORY STATEMENT.

In the following pages a brief statement of the conditions affecting production in the principal districts of the country is presented, the geologic occurrence of the ores is briefly summarized, and the tenor of ore from each district is given when this will not disclose the production of individual companies, the figures of whose output have not already been published in their annual report or elsewhere.

Those desiring more detailed information of the mining operations of the districts are referred to the reports on mine production for the various States, which are published by the United States Geological Survey and which, with this and other reports, form the first part of the volume Mineral Resources of the United States for 1913, as shown in the prefatory note.

The report for 1910 contained a map showing the location of the principal copper producing districts of the United States and the location of the principal reduction plants. The map has not been reproduced in this report, but copies can be obtained on application to the Director of the United States Geological Survey.

Where figures of metal output, ore reserves, recovery in treatment, etc., of individual companies are given in this report, unless otherwise stated, it is to be understood that they are quoted from the official report of the company.

ALASKA.

The production of blister copper from Alaska in 1913 was 23,423,070 pounds, as compared with 31,926,209 pounds in 1912. The decrease is due to reduced output from the Copper River district caused by the partial destruction of the plant of the Kennicott-Bonanza mine and the consequent interruption of operations. The mine production of copper for 1913 was 21,659,958 pounds, the larger smelter production resulting from the treatment of some ore mined in 1912.

Important productions of copper from Alaska began about 1903, since which time it has been a steady contributer of that metal. To the close of 1913 the total production of blister copper has been 114,475,613 pounds. The output for 1913 was from the Ketchikan, Prince William Sound, and Copper River districts.

Ketchikan district.—Production in the Ketchikan district was again small in 1913 as for several years previous. The deposits of the district[1] thus far developed are of contact origin, the ores run high in iron, being composed of pyrrhotite, magnetite, pyrite, and chalcopyrite, and are desirable ores for the British Columbia and Washington smelters. The ores were shipped to the Tacoma smelter. Only the relatively high-grade ores are shipped, as the low-grade material can not be marketed profitably. The average yield in copper is between 4 and 5 per cent, and the ores carry rather low values in gold and silver.

Prince William Sound district.—Copper mining in the Prince William Sound district was active, the output being one of the largest made by this district. The ores of the district were shipped to the Tacoma smelter. The deposits[2] consist of pyrrhotite, chalcopyrite, and pyrite, with minor quantities of other sulphides occurring chiefly in shear zones in greenstone and to a less extent in sedimentary rocks. The largest producer was the Beatson Bonanza mine, though the Ellamar

[1] For detailed descriptions, see Wright, C. W., and Paige, Sidney, Mineral resources of Alaska in 1907: U. S. Geol. Survey Bull. 345, pp. 98–115, 1908; Wright, F. E., and Wright, C. W., The Ketchikan and Wrangell mining districts, Alaska: U. S. Geol. Survey Bull. 347, 1908; and Smith, P. S., Lode mining in the Ketchikan region, Alaska: U. S. Geol. Survey Bull. 592, pp. 75–94, 1914.

[2] Grant, U. S., and Higgins, D. F., Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska: U. S. Geol. Survey Bull. 443, pp. 87–96, 1910; Capps, R. S., and Johnson, B. L., Mineral deposits of the Ellamar district: U. S. Geol. Survey Bull. 542, pp. 86–124, 1912; Lincoln, F. C., the Big Bonanza copper mine, Latouche Island, Alaska: Econ. Geology, vol. 4, pp. 201–213, 1909; Thompson, A. P., On the relation of pyrrhotite to chalcopyrite and other sulphides: Econ. Geology, vol. 9, pp. 171–173, 1914.

mine was an important producer, and others also contributed. Other copper properties were being developed.

Copper River district.—The Kennicott-Bonanza mine was the only producer in the Copper River district. The plant at this mine was partially destroyed during the year and production seriously interfered with. Development of other properties was active during the year.

The primary ores [1] of the Bonanza mine are principally chalcocite with some bornite, replacing limestone near a greenstone contact. These minerals have been to slight extent altered to carbonates at the surface. This is one of the few important copper deposits known in which chalcocite, the principal ore mineral, is regarded as a primary mineral. Much of the ore is almost pure chalcocite and is very high grade, while the lower grade ore with a limestone gangue is susceptible of high concentration.

ARIZONA.

In 1913 Arizona produced 404,278,809 pounds of blister copper, as compared with 359,322,096 pounds in 1912. This is the largest output in the history of the State, or of any State, and continues Arizona in first place among the copper-producing States.

The steady output of copper from Arizona began about 1875, though there was intermittent production prior to that date, the earliest record of production being for 1862. Since 1880 the growth of the industry has been steady and rapid. To the close of 1913 Arizona had a recorded production of 4,266,987,705 pounds of copper, or 22.63 per cent of the total output of the country, thus ranking third among the States in total production. Arizona produced 33.02 per cent of the total output of the country for 1913.

Eleven copper-smelting plants were operated within the State during the year.

The greater part of the production was from five districts.

Bisbee district.—The Bisbee or Warren district, in southern Cochise County, was the largest producer, with about 155,100,000 pounds of blister copper, as compared with 140,000,000 pounds in 1912. Production in the district began in 1880, since which time it has been a constant and increasingly important contributor to the output of copper. To the close of 1913 it had produced 1,710,300,000 pounds of copper, or 9.07 per cent of the output of the country and 40.16 per cent of the Arizona production. In total and in present output it ranks third among the copper districts of the country.

The oldest rocks [2] in the Bisbee district, according to Ransome, are the pre-Cambrian Pinal schist, which has been intruded by granite, probably also of pre-Cambrian age. On this basement were

[1] Moffit, F. H., and Maddren, A. G., Mineral resources of the Kotsina-Chitina region, Alaska: U. S. Geol. Survey Bull. 374, 1909; and Moffit, F. H., and Capps, S. R., Geology and mineral resources of the Nizina district, Alaska: U. S. Geol. Survey Bull. 448, 1911.

[2] For detailed geologic report, see Ransome, F. L., Geology and ore deposits of the Bisbee quadrangle, Arizona: U. S. Geol. Survey Prof. Paper 21, 1904; Rice, C. T., Camp of Bisbee, Arizona: Mines and Methods, Salt Lake City, Utah, vol. 1, p. 241, 1909; Weed, W. H., Is geology a success as a guide to ore deposits: Min. and Eng. World, vol. 27, p. 245. Douglas, James, Notman, Arthur, Legrand, Charles, and Lee, George B., The Copper Queen mines and works, Arizona, U. S. A.: Inst. Min. and Met. Trans., vol. 21, pp. 532–590, 1913; Eng. and Min. Jour., March 8, 1913; Ransome, F. L., Notes on the Bisbee district, Arizona: U. S. Geol. Survey Bull. 529, pp. 179–182, 1913; Jenney, J. B., Bisbee prophyry deposits: Eng. and Min. Jour., vol. 97, p. 467, 1914.

deposited upward of 5,000 feet of Paleozoic sediments, consisting for the most part of limestone with quartzite at the base. These beds were intruded in early Mesozoic time by stocks, dikes, and sills of granite porphyry. After a period of erosion Cretaceous sediments were deposited on the earlier formations, which have since been largely removed from the producing area.

The primary ores were deposited during and after the intrusion of the granite prophyry and were genetically connected with that intrusion. The presence of garnet, tremolite, diopside, and other silicates associated with the ore minerals indicates a contact origin of the deposits.

The principal ore bodies occur around the prophyry stock of Sacramento Hill and along faults and fissures where the ore minerals have replaced the limestone. The most important ore bodies thus far developed have been in the Carboniferous and Devonian limestones, but in recent years important deposits have been discovered in the Cambrian limestone, and ore has also been developed in the granite porphyry.

The following notes on the porphyry ores are taken principally from Mr. Jenney's description:

The desseminated ores occur in granite porphyry and "silica breccia" that is probably an alteration of the porphyry. Previous to October, 1913, two important bodies of ore had been developed by underground methods. From the Sacramento shaft a body of ore has been blocked out extending from the 400-foot to the 200-foot level, and approximately 300 feet by 100 feet in cross section with an east and west trend. From the air shaft a body has been developed between the 200-foot and 100-foot levels and above. An area about 800 feet by 200 feet has been blocked out. Since October, 1913, development by churn drill has been in progress. The ore consists of chalcocite, some bornite and chalcopyrite, and considerable pyrite in a siliceous gangue.

In the northern part of the district the ore deposits in the sedimentary rocks are frequently closely associated with porphyry bodies and this association serves to some extent as a guide in prospecting, but in the southern end of the district porphyry intrusions are less abundant and the ore bodies occur associated with fissures.

The primary ores of the district consist mainly of pyrite and chalcopyrite with smaller bodies of galena and some sphalerite. Alteration by surface solutions has extended to great depth and a large part of the ore extracted has been oxidized ore and secondarily enriched sulphide ore. In recent years, however, there has been developed large bodies of primary sulphides of commercial grade. Most of the ore of the district occurs in irregular bodies without very definite arrangement and the cost of prospecting is consequently rather high. The irregular character of the ore deposits and the heavy ground, especially in the oxidized ore bodies, has resulted in relatively high cost of extraction. Recently, however, modifications in the system of mining have resulted in a decrease in the timber used per ton of ore and also in the cost of extraction. The cost of mining will, however, doubtless remain relatively high as compared with districts where cheaper systems of mining can be safely and economically employed.

Developments during the year apparently resulted in an increase in the ore reserves of the district, though it is not the policy of the principal companies to develop large reserves in advance of extraction.

An interesting development of the year was the discovery of ore on the Wade Hampton and the White Tail Deer claims of the Copper Queen Co., west of Bisbee, in an area hitherto but slightly developed. Important bodies of ore were discovered in the Lowell and Sacramento divisions of the Copper Queen mine, and important extensions to known ore bodies have been made in other parts of the district.

For 1913 the average recovery was about 5.6 per cent copper and an average precious metal value of $1.16 per ton of ore.

The following table shows the production of the Copper Queen mine:

Production of the Copper Queen Consolidated Mining Co. in 1913.

	Dry weight.	Gold.	Silver.	Copper.	Lead.
Shipped to Douglas:	*Short tons.*	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*
Ore	712,444	14,443	680,939	88,890,368	.....
Precipitates	603	.....	95	437,008	.....
Old dump slag	93,578	.....	7,394	3,639,386	.....
Old dump slag by lessees	634	.....	50	23,510	.....
Ore from lessees	21,524	364	19,974	3,423,883	.....
Flue dust from lessees	44	.....	35	7,922	.....
Ore from experimental leaching plant	4,765	3	233	134,524	.....
Shipped to El Paso:					
Ore mined by company	14,800	743	198,426	267,549	5,423,404
Ore mined by lessees	773	153	4,788	23,240	278,224
Shipped to Globe:					
Sulphide ore	18,316	507	7,204	334,335	.....
Total	867,481	16,213	919,138	97,181,725	5,701,628

The company reports at the close of 1913 developed ore reserves of the limestone deposits of 2,567,928 tons and of lean sulphide 211,199 tons, a total reserve of this type of 2,356,729 tons. This does not include the porphyry ores already mentioned. The company reports net earnings of $6,916,900.47. Dividends paid in 1913 amounted to $5,700,000.

The Calumet & Arizona Mining Co. produced a total of 52,621,651 pounds of refined copper, 540,213 ounces silver, and 15,890 ounces gold.

The following tables show the production and yield of ores by the Calumet & Arizona and Superior & Pittsburg companies in 1913:

Production of the Calumet & Arizona Mining Co. in 1913.

	Wet.	Dry.
Tons ore mined	106,588	102,892
Tons ore shipped	107,926	104,177
Tons ore sampled	111,541	107,701
Pounds copper recovered per ton ore	89.69	
Per cent copper recovered per ton	4.485	
Per cent assay per ton dry ore	4.932	

Production of Superior & Pittsburg Mining Co. in 1913.

	Wet.	Dry.
Tons mined	393,941	359,333
Tons ore shipped to smelter	376,452	342,160
Tons ore sampled	376,568	342,301
Pounds copper recovered per ton ore	115.698	
Per cent copper recovered	5.785	
Per cent assay per ton dry ore	6.272	

The net cost of producing copper by the combined companies for the year was 7.65 cents per pound. The net income of the combined companies was $4,074,637.58 and dividends were paid during the year to the amount of $3,059,208.75.

In the following table is given the production of the Shattuck Arizona Copper Co. for 1913:

Production of the Shattuck Arizona Copper Co. in 1913.

	Copper ore.		Lead ore.	
	Wet.	Dry.	Wet.	Dry.
Tons ore mined	99,135	89,857	5,240	5,010
Tons ore shipped	99,075	89,317	5,090	4,874
Tons ore smelted	99,089	89,343	5,090	4,874
Pounds recovered per ton	133.412	147.960	291.530	304.481
Per cent recovered per ton	6.670	7.398	14.576	15.224
Total pounds copper recovered	13,219,756			
Total ounces silver recovered	236,000			
Total ounces gold recovered	2,033.43			
Value of gold and silver recovered per ton of ore smelted	$2.03			

The company reports net profits from August 1, 1912, to December 31, 1913, of $1,150,879.92. Dividends were paid to the amount of $525,000.

At Douglas the plants of the Copper Queen and the Calumet & Arizona companies were operated throughout the year.

The new plant of the Calumet & Arizona Co.[1] was placed in commission in June and the old plant closed the same month and later dismantled. With minor exceptions the operations of the new plant were highly successful.

Experimental work to determine a method of leaching low-grade ores and concentrator tailings was carried on by the Copper Queen Co. The development of bodies of disseminated ore in the camp will doubtless result in the construction of a concentrating plant in the district.

The district is served by the El Paso & Southwestern Railroad. Oil for fuel is used extensively in the production of power, which is generated in central plants and distributed to the places where needed.

[1] The plant has been described by R. H. Vail (Calumet & Arizona's new smelting works at Douglas, Ariz.: Eng. and Min. Jour., vol. 98, p. 102, 1914).

Morenci-Metcalf district.—The deposits of the Morenci-Metcalf district are at Morenci and Metcalf, in Greenlee County. During 1913 the district produced 70,100,000 pounds of blister copper, as compared with about 79,900,000 pounds in 1912.

The district was one of the earliest copper producers in the State, the output beginning as early as 1873, and since 1880 it has been an important contributor to the copper output of the country. To the close of 1913 a total of 1,104,200,000 pounds of copper had been produced, or 5.86 per cent of the output of the country since 1845 and 25.93 per cent of the output of the State. In total production it ranks fourth among the copper districts of the country and second in the State; in the output for 1913 it ranks sixth in the country and third in the State.

The copper ores[1] of this district occur as contact deposits in Paleozoic limestones and shales which have been intruded by stocks and dikes of porphyry, as disseminated deposits mainly in the porphyry, and as deposits in fault fissures of the Coronado type.

The original ores were pyrite and chalcopyrite of too low grade to be of economic importance. The workable bodies have resulted from the process of secondary enrichment. The ore bodies in the limestone were formed in certain beds favorable to deposition, and this produced roughly tabular bodies nearly parallel to the stratification of the limestone. Alteration of these bodies has produced oxidized ores which formed most of the workable ores in the limestone. These are now nearly exhausted.

The disseminated ores occur in highly altered porphyry adjacent to fissure veins. The copper content of the upper portion of these deposits has been leached and deposited as chalcocite on the pyrite lower down. This has produced a zone of commercial ore varying in thickness, in general not extending below a depth of 400 feet.

In the fault fissure or Coronado type of deposit commercial ore has been developed to much greater depth, and recent exploration of the principal faults in Copper Mountain has shown that commercial ore occurs associated with these faults considerably below the general level of the ore zone.

Of the 1913 mine production of copper, 51,398,000 pounds were derived from concentrating ores and 17,697,000 pounds from smelting ores. The mines of the district produced 1,494,447 tons of concentrating ores, yielding 1.72 per cent copper, and 229,630 tons of smelting ore, yielding an average of 3.88 per cent copper—the average yield for the 1,724,077 tons of ore produced in the district being 2 per cent.

The ores in general carry low gold and silver values, and as much of the copper is of sufficient purity for commercial purposes it is not refined electrolytically, and consequently the precious metal content is not recovered.

Modified systems of slicing and caving ore now very largely employed in the extraction of ore and the amount of timber required has thus been very materially reduced from what it was when the square set method prevailed.

[1] For detailed report of the Clifton-Morenci district see Lindgren, Waldemar, The copper deposits of the Clifton-Morenci district, Arizona: U. S. Geol. Survey Prof. Paper 43, 1905; Tovote, W. L., Min. and Sci. Press, vol. 101, p. 770, 1910.

The following table gives a summary of the production of the mines of the Detroit Copper Co. for 1913:

Ore production of the Detroit Copper Co., Arizona, in 1913, in short tons.

	Quantity.	Grade.
		Per cent.
Concentrating ore	518,718	2.785
Smelting ore	5,330	11.80
Quartz ore	8,380	3.23
Talc	364	5.73
Lease ore, miscellaneous:		
Santa Rosa	259	13.98
Summit	6	10.003
Montezuma	323	4.286
Thompson	20	7.467
Yankie	76	11.317
London	5	6.747
Copper precipitates	82	43.9
Total	533,563	2.89

The following table shows the result of concentrating operations of the Detroit Copper Co. during 1913:

Result of concentrating operations of the Detroit Copper Co. during 1913.

	Percentage of copper.
Ore concentrated (517,518 tons)	2.785
Concentrates produced (66,928 tons)	15.834
Savings:	
Ore and concentrates	73.52
Ore and tailings	75.18
Concentrates and tailings	74.76
Assay only	75.27
Tailings assay	.79
Tons ore milled per ton concentrates	7.73

The Detroit Copper Co. reported net earnings for the year of $1,112,870.42.

During the fiscal year ending September 30, 1913, the Arizona Copper Co. (Ltd.) produced 34,230,000 pounds of copper. The company's mines produced 936,903 dry tons. The average yield in copper per ton of ore treated was 38.76 pounds, or 1.938 per cent. This compares with a yield of 2.057 per cent for the preceding year. Of the total ores, 95 per cent were concentrating ores and 5 per cent smelting ores.

During the year the oxide concentrator treated 106,596 dry tons of ore, tailings from which, amounting to 85,071 dry tons, were treated by the leacher. This ore yielded 9.27 per cent of the total copper produced.

The new smelting works [1] began operation in August and from that time there was a reduction in the operations at the old plant, which was finally closed at the end of the year.

Production by the Shannon Copper Co. for the 16 months ending December 31, 1913, amounted to 18,793,724 pounds of copper, 3,412 ounces of gold, 169,197 ounces of silver. During the same period

[1] The new plant has been fully described by R. H. Vail (Eng. and Min. Jour., vol. 97, pp. 1279-1283, and vol. 98, pp. 11-16, 1914).

361,084 tons of ore were produced from the Shannon mine, yielding an average of 46.78 pounds of copper per ton, and 73,223 tons of ore from outside properties, yielding an average of 22 pounds per ton.

The average cost of copper for the period was 13.5 cents a pound. The net profits for the period amounted to $476,440.42.

Jerome district.—The Jerome or Verde district of Yavapai County produced about 35,300,000 pounds of blister copper in 1913, as compared with about 31,680,000 pounds in 1912. The production of copper in the district began about 1883, though it had yielded gold and silver prior to that time. Since 1888 it has been a steady and important producer.

To the close of 1913 it has yielded a total of 670,180,000 pounds of copper, or 3.56 per cent of the total output of the country since 1845, and 15.74 per cent of the total output of the State. In total output it stands sixth among the copper districts of the country and third in Arizona. In output for 1913 the district ranks tenth among those of the country and fifth in Arizona.

The rocks[1] in which the United Verde deposit occurs are pre-Cambrian schistose rocks, resulting from the metamorphism of dioritic, rhyolitic, and possibly sedimentary rocks. The material most favorable to replacement by ore is a fissile sericitic schist.

According to Ransome:

> The ore shoot as a whole is of oval plan, its total horizontal length being about 1,300 feet and its greatest width 700 feet. Its general trend is north-northwest and it pitches in that direction at an angle of 45°. It has been worked to a vertical depth of 1,200 feet with no sign of approaching exhaustion. This great shoot is in reality a complex of smaller but nevertheless large irregular or lenticular ore bodies, apparently related in part to cross fissuring but showing a general tendency toward parallelism with the schistosity.
>
> The important ore constituent is chalcopyrite, associated with varying proportions of pyrite and sphalerite. Bornite has been reported but was not noted in 1912. Neither galena nor pyrrhotite was observed at the time of visit. The sulphides occur partly in small irregular fractures and along planes of schistosity, but to a large extent they have metasomatically replaced the schist, particularly the fine-grained sericitic variety. The ore contains very little vein quartz or other gangue mineral.
>
> The sulphides mentioned are primary and were deposited in pre-Cambrian time.

The ores differ from most of the large copper deposits of Arizona in carrying rather high gold and silver values. The copper content of the ore is also unusually high for this type of deposit.

As little timber as possible is employed in mining on account of the danger from fire.

Considerable copper is recovered by precipitation on scrap iron from the mine waters that have leached through the burning stopes.

The United Verde Copper Co. was the only important producer during the year. This company has constructed a new smelting plant[2] for the treatment of its ores at Clarkdale, on the west side of Verde River, about 5 miles from Jerome.

Development was carried on by other companies in the district during the year, but no important production was made. The district is served by a narrow-gage railroad owned by the United Verde Copper Co., which connects with the Santa Fe, Prescott & Phoenix Railway.

---

[1] Graton, L. C., U. S. Geol. Survey, Mineral Resources 1907, pt. 1, p. 597, 1908; Ransome, F. L., U. S. Geol. Survey Bull. 529, p. 192, 1913.

[2] The new plant is described by R. H. Vail (Eng. and Min. Jour., vol. 96, pp. 287–292, 1913).

Globe district.—The Globe district of Gila County produced about 71,000,000 pounds of blister copper in 1913, as compared with about 61,600,000 pounds in 1912.

Production of copper began in the district about 1881; the camp was well known as a silver producer before that date. For several years subsequent to 1881 the production was intermittent, but since 1888, and especially since 1898, when the railroad reached the camp, the district has ranked among the important copper producers of the country. To the close of 1913 it has produced a total of 511,900,000 pounds of copper, or 2.72 per cent of the output of the country since 1845, and 12.24 per cent of the output of the State. In total production the district ranks seventh in the country and fourth in the State; for 1913 it ranks fifth in the country and second in the State. Important production began in the Miami section in 1911, and this section of the district will continue to grow in importance.

The geology [1] of the district may be briefly summarized as follows: Paleozoic sediments, consisting of conglomerates, quartzites, shales, and limestones, were laid down unconformably on a pre-Cambrian basement of schist and intruded granitic rocks. In post-Paleozoic time the region was invaded by an intrusion of diabase followed by an intrusion of granitic rock. After a period of erosion the area was partly or wholly buried beneath Tertiary volcanic and sedimentary rocks which have since been partly removed by erosion.

The copper deposits are believed to have been introduced at the time of or closely following the post-Paleozoic granitic intrusion, and the source of the copper-bearing solutions is believed to have been connected with this igneous rock. The deposits of the district are of quite different types, dependent largely upon the nature of the rocks in which they were formed. In the Globe end of the district the deposits occur as roughly lenticular deposits replacing limestone, and as fault lodes or fissure zones of quartz and sulphide in diabase.

In the Miami end of the district the ores occur mainly as small veins of quartz and sulphide in the shattered rock near the granite schist contact, the mineralization occurring in both formations.

In the Globe section of the district most of the ores developed to the present time owe their commercial value to enrichment. The ore extracted from the limestone has been largely oxidized, and much of the ore developed in the diabase has been enriched sulphide. Under favorable conditions the enrichment has gone on to the greatest depth to which development has extended. Some bodies of primary ore of commercial grade have also been developed.

In the disseminated bodies of the Miami section the original ore was sulphides of iron and copper. The copper content of the ores near the surface has been partly taken into solution and redeposited as chalcocite on the sulphides lower down. The commercial ore consists of grains of pyrite and chalcopyrite partly or wholly replaced by chalcocite. The commercial bodies of ore are blanket-like deposits

[1] For detailed description, see Ransome, F. L., Geology of the Globe copper district, Arizona: U. S. Geol. Survey Prof. Paper 12, 1903; Geology at Globe, Ariz.: Min. and Sci. Press, vol. 100, p. 256, 1910; Geology of the Globe district, Ariz.: idem, vol. 102, p. 747, 1911; Tolman, C. F., jr., Min. and Sci. Press, vol. 99, p. 646, 1909; Higgins, Edwin, Eng. and Min. Jour., vol. 89, pp. 769, 813, 870, 1910; Ransome, F. L., U. S. Geol. Survey Bull. 529, pp. 183–186, 1913; Tovote, W. L., Globe mining district, Ariz.: Min. and Sci. Press, vol. 108, pp. 442–449 and 487–492, 1914.

overlain by leached "capping" and underlain by primary material too lean in copper content to be classed as commercial ore.

In places overlying the sulphide ore there is a considerable quantity of oxidized and partly oxidized ore of a grade that will permit of extraction when a satisfactory method of recovering the metal is available.

An exceptional type of ore is that of the Black Warrior mine, which is oxidized ore cementing dacite tuff or brecchia.

The ores in the Globe end of the district vary greatly in copper content, the grade to be treated at any given time depending largely on the possibility of profitable treatment. In general, ores of as low grade as can be handled with reasonable profit are mined. During 1913 the ores of the entire district yielded about 2.38 per cent of copper, with about 16 cents in gold and silver per ton. The mines of the district produced 1,210,922 tons of concentrating ore yielding an average of 1.67 per cent copper and 272,376 tons of smelting ore yielding an average of about 5.52 per cent copper.

The Old Dominion smelter was the only reduction plant operating in the district during the year.

The International Smelting & Refining Co. had under construction a smelter to treat the concentrates of the Inspiration Consolidated mine. In 1914 this company was purchased by the Anaconda Copper Mining Co.

The district is served by the Arizona Eastern Railroad.

The Old Dominion and the United Globe mines at Globe and the Miami mine at Miami were the largest producers during the year. The ore produced by the Old Dominion Co. is shown below.

Ore produced by Old Dominion Copper Mining & Smelting Co., Arizona, in 1913, in short tons.

	Quantity.	Percentage of copper.
Smelting ore	120,257	6.85
Concentrating ore	47,785	3.56
Silica lining	1,919	3.37
Total	169,961	5.88

The ores of the Old Dominion mine yielded 18,945,153 pounds of copper, 51,316.94 ounces silver, and 419.824 ounces gold.

Net earnings of the company for the year were $1,043,793.14, and dividends were paid amounting to $810,000.

The following table shows the production of the United Globe Mines for 1913:

Ore produced by United Globe Mines, Arizona, in 1913, in short tons.

	Quantity.	Percentage of copper.
Smelting oxide	27,978.63	6.74
Smelting sulphides	18,188.93	2.07
Concentrating ore	102,388.67	2.61
Silica converter lining	14,278.82	4.50
Slag	5,084.62	1.95
Total	167,919.67	3.38

The total metal production was 11,348,100 pounds of copper, 119,588 ounces of silver, and 1,537 ounces of gold.

Net earnings for 1913 amounted to $481,445.80 and dividends to the amount of $690,000 were paid.

The following table shows the results of milling operations of the Miami Copper Co.

Milling operations of Miami Copper Co., Arizona, in 1913.

Ore milled	short tons	1,058,784
Percentage of copper in ore		2.30
Concentrates produced	tons	45,410
Percentage of copper in concentrates		38.09
Copper in concentrates	pounds	34,597,568
Copper recovered per ton of ore	do	32.68
Mill extraction	per cent	71.06

The net smelter returns of refined copper from concentrates amounted to 32,867,666 pounds. Based on the net production, the cost of copper in concentrates on board cars at Miami was as follows:

Cost of copper f. o. b. cars at Miami in 1913.

	Per ton of ore.	Per pound of copper.
Mining	$1.6030	$0.05164
Milling	.5722	.01843
General	.2899	.00900
Total	2.4651	.07907

The total cost of producing and marketing copper for the year was 10.6086 cents per pound.

On January 1, 1914, the ore reserves were estimated as 20,300,000 tons with an average copper content of about 2.45 per cent. In addition there is developed 17,200,000 tons of material averaging 1.21 per cent copper. This material at present is not regarded as commercial ore, but it may become commercial some future time. In addition developments indicate a body of oxidized or partly oxidized ore which contains about 6,000,000 tons averaging about 2 per cent copper. During 1913 the company paid dividends to the amount of $1,491,989.

During 1913 the Inspiration Copper Co. continued preparation at its mine for the extraction of ore and for the erection of its concentrating mill. A 600-ton flotation unit was constructed and started in January, 1914. The management report that the average results for several weeks' run were better than has been accomplished on similar ores by water concentration and that the recoveries are improving. The mill is to have a capacity of 10,000 tons daily. The treatment will consist in part of the ordinary table concentration and will be so designed that it can be changed entirely to this method if found desirable.

The ore reserves at the close of the year are shown in the accompanying table:

Ore reserves of the Inspiration Consolidated Co., Arizona, January 1, 1914, in short tons.

	Quantity.	Percentage of copper.
Sulphide ore	45,000,000	2.00
Low sulphide material	28,322,000	1.26
Oxidized material	12,445,000	1.34
Mixed carbonate and sulphide material	3,876,000	1.24
Total	89,643,000	1.64

The New Keystone Copper Co. carried on experiments to determine a method for the treatment of its ores.

Mineral Creek or Ray district.—The Mineral Creek or Ray district, Pinal County, produced 52,340,000 pounds of blister copper in 1913, as compared with about 34,600,000 pounds in 1912. Important production in the district began in 1911. The total output to the close of 1913 has been about 102,640,000 pounds.

The geology [1] of the district is very similar to that of the Globe district to the north. Paleozoic sediments have been deposited on a basement of pre-Cambrian schists. In post-Carboniferous time the region was invaded by an intrusion of diabase and later by a granitic intrusive of varying composition. After a period of erosion the area was buried beneath Tertiary volcanic and sedimentary rocks. Later it was elevated, faulted, and the covering of Tertiary sediments partly removed. The ore deposits of the district are of two distinct types—those formed in the sedimentary rocks adjacent to faults and fissures, and the disseminated deposits in the schists and granite. The ores of both types are believed to have been introduced at the time of and closely following the granitic intrusion.

The deposits of the first type are found east of the Ray fault. The ores are mainly oxidized. To the present time important production has not been made from this type, nor have large ore reserves been developed.

The disseminated deposits occur in crushed schists and "granite." The original mineralization was pyrite and chalcopyrite, but the commercial ore has resulted from enrichment of the deposits produced by the leaching of the copper values from the upper portion and the redepositing them as chalcocite on the sulphides lower down. This has resulted in a blanket-like deposit of commercial ore covered by a relatively barren capping and underlain by a zone of original mineralization too low in copper content to be of commercial value.

The average thickness of the leached zone or "capping" in the Ray Consolidated ground is 252 feet, and the average thickness of the ore 101 feet. Locally, especially associated with the diabase, native copper becomes of some importance.

The district is served by the Arizona Eastern Railroad. The mines and reduction works are connected by the Ray & Gila Valley Railroad, controlled by the Ray Consolidated Copper Co.

[1] Ransome, F. L., Geology of the Globe district, Arizona; Min. and Sci. Press, vol. 102, p. 747, 1911; Weed, W. H., The Ray copper mining district, Arizona: Mining World, vol. 34, p. 53, 1911; Tolman, C. F., jr., Disseminated chalcocite deposits at Ray, Ariz.: Min. and Sci. Press, vol. 99, p. 622, 1909; Clifford, J. O., Ray Consolidated properties: Mines and Methods, Salt Lake City, Utah, vol. 4, p. 83; Ransome, F. L., U. S. Geol. Survey Bull. 529, p. 186, 1913.

No development of ore except incidental to mining operations was accomplished during the year. Ore reserves at the beginning of 1914 were estimated at 78,380,966 tons, averaging about 2.2 per cent copper.

A total of 2,365,296 tons of ore with an average copper content of 1.719 per cent was milled and yielded in concentrates 53,745,937 pounds of copper. The average recovery in concentrates was 66.09 per cent or 22.723 pounds per ton. In addition to copper in concentrates crude smelting ore with a copper content of 412,372 pounds was shipped. The average cost of copper for the year was 9.7836 cents a pound. The net profit for the year was $2,675,193.39. Dividends were paid to the amount of $1,631,504.35.

The concentrates were treated at the plant of the American Smelting & Refining Co., at Hayden.

Silver Bell district.—As for several years past, there was little activity in the Silver Bell district of Pima County. This district has yielded about 41,800,000 pounds of copper.

Turquoise district.—Shipments of copper from the Turquoise district during the year amounted to about 6,200,000 pounds. The Paleozoic sediments[1] of the district have been extensively faulted and intruded by monzonitic porphyries. The copper deposits of the district may be grouped as follows:

(1) Oxidized blanket deposits connected with thrust faulting, exemplified by the ore bodies of the Germania and Mary mines. (2) Pyritic deposits with some associated bodies of oxidized ore in the Cambrian dolomitic limestone and shale, exemplified by the Mame and Leadville mines. (3) Pyritic deposits with associated bodies of oxidized or enriched ore in Carboniferous limestone, exemplified by the Copper Belle and other mines near Gleeson.

Ajo district.—The Calumet & Arizona Copper Co. has developed extensive deposits of disseminated ore on the property of the New Cornelia Copper Co., at Ajo, Pima County, about 45 miles from the Southern Pacific Railroad at Gila Bend.

The company estimates the ore as follows: Carbonate ore, 11,954,400 tons averaging 1.54 per cent copper; sulphide ore, 28,303,600 tons averaging 1.50 per cent copper; total, 40,258,000 tons averaging 1.51 per cent copper. Of this, 11,954,400 tons of carbonate ore and 20,526,800 tons of sulphide ore are available for steam-shovel mining.

The rocks[2] of the district consist of a series of lavas, breccias, and tuffs which have been intruded by stocks of quartz monzonite porphyry and allied rocks. The original copper deposits consist of small veins containing chalcopyrite and bornite for the most part in the intrusive rock but also present in the extrusive rocks. Oxidation has been extensive but there has been no important leaching of the copper from the oxidized ores. It is proposed to extract the copper from the oxidized ores by a leaching process.[3]

Other districts of the State that made important productions of copper were the Big Bug and Copper Basin districts of Yavapai County, the Palmetto district of Santa Cruz County, the Pima district of Pima County, and the Pioneer district of Pinal County.

---

[1] Ransome, F. L., The Turquoise copper-mining district, Arizona: U. S. Geol. Survey Bull. 530, pp. 125–134, 1912.

[2] Jorlemon, I. B., The Ajo copper mining district: Am. Inst. Min. Eng. Bull., pp. 2011–2028, August, 1914.

[3] Croasdale, Stuart, Leaching experiments on the Ajo ores: Am. Inst. Min. Eng. Bull., pp. 1881–1929, August, 1914.

CALIFORNIA.

In 1913 California produced 32,492,265 pounds of blister copper, as compared with 31,516,471 pounds in 1912. The reduction in output for the State in recent years is due to the necessity of eliminating from the smelter "smoke" ingredients injurious to vegetation, which has resulted in the shutting down of all but one of the smelters in the Shasta County district.

California was among the earliest of the Western States to make an important output of copper. Production began in the "Foothill" belt about 1862 and for several years was an important industry, California being second only to Michigan in its copper production. In a few years, however, the industry declined, and California did not have important rank as a copper producer until 1897, when production from the Shasta County district began. Since that time there has been a steady and important output from the State. The production for the early years has been ascertained from the best sources available, and adding to this the known production since 1882, it is found that to the close of 1913 California has produced about 544,979,344 pounds of copper, or 2.89 per cent of the output of the country since 1845. In 1913 the output was 2.65 per cent of the total production of the United States. In total output the State ranks fifth among the copper producers of the country, and for 1913 it ranked seventh. Three plants in the State treated copper ores in 1913.

The main production has come from two districts, though numerous other districts have made small outputs, and copper minerals are widely distributed over the State. The largest producer has been the Shasta County district and the next most important the "Foothill" district.

Shasta district.—The Shasta County copper belt is situated in the Klamath Mountains, at the head of the Sacramento Valley, a few miles north of the town of Redding. Sacramento River crosses the belt, separating it into an eastern and a western portion, the eastern portion containing the Bully Hill and the Afterthought districts, and the western, the Iron Mountain and the Little Backbone districts. Placer mining was carried on in the district in the early days of mining in the State, and later considerable silver was produced from the gossan outcrop of the copper deposits. Although copper minerals have been long known from the district, it was not until 1897, when the Mountain Copper Co. (Ltd.) began production at Iron Mountain, that it became an important contributor of copper. In 1913 the district produced about 26,800,000 pounds of copper, as compared with about 26,000,000 pounds in 1912. The total production to the close of 1913 has been about 418,700,000 pounds, or about 2.23 per cent of the total output of the country. In 1913 the district produced about 2.19 per cent of the total output. In total output the district ranks eighth and in the production for 1913 it ranked eleventh among the copper districts of the country.

The inclosing rock[1] of the most of the ore bodies is an intrusive alaskite porphyry of Mesozoic age. The ore minerals have replaced

[1] Diller, J. S., U. S. Geol. Survey Geol. Atlas, Redding folio (No. 138), 1906; U. S. Geol. Survey Bull. 213, pp. 123–132, 1903; U. S. Geol. Survey Bull. 225, pp. 169–179, 1904; Graton, L. C., The occurrence of copper in Shasta County, Cal.: U. S. Geol. Survey Bull, 430, p. 71, 1910; Boyle, A. C., Geology and ore deposits of the Bully Hill mining district, California: Am. Inst. Min. Eng. Bull., pp. 57–105, January, 1914.

this rock along zones of shearing. In the western district the ores thus far developed are large flat-lying, more or less tabular bodies of no great vertical extent. In the eastern district they have more the character of veins and locally form deposits in the adjoining sediments.

The ore in the western district is pyrite, with a small percentage of chalcopyrite and varying amounts of sphalerite. In the eastern district sphalerite becomes an important constituent.

Rich secondary sulphite ores were found underlying the gossan at Iron Mountain and Bully Hill, but these have been exhausted.

The ores carry values in precious metals, those of the eastern district being rich in them. The average metal content of the copper ores from the district for 1913 was 3.50 per cent of copper, with $1.76 per ton in precious metals.

The principal producing companies in 1913 were the Mountain Copper Co. and the Mammoth Copper Co. The ores of the Mammoth Co. were smelted at their plant at Kennett, and the Mountain Co.'s ores were smelted at their Martinez plant on San Francisco Bay.

Experimental work was carried on at the Balaklala smelter at Coram and also at Bully Hill to develop methods for treatment of the ores without injury to the vegetation of the region.

The extraction of ore from the Mammoth mine amounted to 259,105 tons. Ore developed during the year was sufficient to replace that extracted and to add materially to the ore reserves of the company. What are regarded as especially promising developments were carried on in section 29, where ore of excellent grade both in copper and in precious metals was disclosed.

The United States Smelting, Mining & Refining Co., of which the Mammoth is a subsidiary, purchased the Spread Eagle group during the year. Any ore developed in this group will be tributary to the Mammoth smelter.

The Iron Mountain Co. treated 126,239 tons of ore during the year derived as follows: Iron Mountain mine, 20,932 tons; No. 8 mine, 40,211 tons; Hornet mine, 64,678 tons; purchased, 418 tons.

A report dated April 10, 1914, gives an approximate estimate of the ore reserves as follows: Old mine, about 5,000 tons; No. 8 mine, positive ore 103,551 tons and probable ore 72,500 tons; Complex mine, 50,000 tons. In addition the Hornet mine contains a large body of low-grade ore. Plans for a concentrating plant to be located at Minnesota on the Iron Mountain Railway were inaugurated during the year.

The Balaklala mine made but small production during the year. As already noted, experiments were carried on at the smelter looking to a method of treating the ores. There was little activity in the eastern districts, as methods of ore treatment have not yet been determined.

Electric power is used almost exclusively at both mines and smelters.

The district is served by the Southern Pacific Railroad, short branches extending to the smelters. The Iron Mountain district is connected with the main line by a narrow-gage railroad operated by the Mountain Copper Co., and the mines of the Mammoth Co. are connected with the smelter by a combined electric railroad, gravity tram, and steam railroad. The ores of the Balaklala mine are delivered to the smelter over a cable tramway.

"Foothill" district.—The "foothill" belt is a rather extensive area of copper deposits which has its best development in Calaveras County. This belt furnished practically the entire copper production from California in the sixties. Following that period of activity, the district was inactive for many years. From 1887 to 1892 the mines made some production. The present period of activity began about 1901, and for some years the district has made important contributions to the copper output of the State.

There is no accurate record of the output of this district in the early days, but from the records of the production of the State it is estimated that to the close of 1913 it has yielded approximately 121,300,000 pounds of copper. The production for 1913 was approximately 5,800,000 pounds. In total output the district ranks twelfth and in production for 1913 seventeenth among the copper districts of the country.

The ores [1] consisting of pyrite and chalcopyrite, occur as lenticular bodies replacing schistose rocks. The ores vary in different parts of the district from those carrying nearly pure pyrite and chalcopyrite with very low gold and silver content to ores carrying considerable lead, zinc, and precious metal. The ores treated during 1913 averaged about 4.55 per cent in copper, with about 2.4 cents in precious metal per pound of copper.

The matte smelter of the Penn Mining Co. was operated in the district.

COLORADO.

In 1913 Colorado produced 9,052,104 pounds of blister copper, as compared with 7,963,520 pounds in 1912. Although the State has no important producing district in which copper is the principal metal, yet it ranked tenth among the copper-producing States in 1913. The total recorded output for the State from the beginning of the industry has been 230,559,548 pounds, or 1.22 per cent of the total output for the United States since 1845. It is probable that the actual output is somewhat in excess of this figure, as some of the copper assigned in the earlier Survey reports to "lead desilverizers" should doubtless be credited to Colorado.

The main production has been derived from the treatment of mixed ores in which copper was of minor importance, including lead-silver ores and pyritic ores rich in gold and silver. The largest production in 1913 was from Lake County and from San Juan, Ouray, San Miguel, Clear Creek, Dolores, and Gilpin counties. Leadville and the San Juan-Ouray districts have been the greatest producers of copper. Much of the output is recovered as matte in lead furnaces.

IDAHO.

During 1913 Idaho produced 8,711,490 pounds of blister copper, as compared with 7,182,185 pounds in 1912. The State has made a small and irregular output of copper since 1884, but only since 1903 has it been a steady and important producer. To the close of 1913 it had a recorded output of 74,965,475 pounds.

The Coeur d'Alene district furnished the largest output for 1913 and has been the most productive copper district in the State. Com-

[1] Knopf, Adolph, California Univ. Dept. Geology Bull., vol. 4, p. 411: Read, J. A., Econ. Geology, vol. 2, p. 380, 1907; Lang, Herbert, Eng. and Min. Jour., vol. 84, p. 909, 1907.

plete figures for the copper output of the district are not on record, but the total production has been approximately 53,793,000 pounds.

The Snowstorm mine is the most important copper producer of the district. This deposit [1] consists of disseminated bornite, chalcocite, and chalcopyrite in certain beds of a pre-Cambrian quartzite; in the upper portion the deposit is oxidized. The lode varies from a few feet to 40 feet in width, and has been developed to a depth of 1,200 feet below the outcrop. Development is by tunnels.

The Alder Creek district was also an important producer.

MICHIGAN.

The production of refined copper in Michigan in 1913 was 155,715,286 pounds, as compared with 231,112,228 pounds in 1912. The great reduction in output was caused by a strike of miners which was called July 23 and continued through the remainder of the year.

The mining of copper in Michigan antedates the earliest visits of European explorers to the region. The production on a commercial basis, however, dates from 1845, since which time the district has been a steady producer and an important factor in the copper industry of the world. To the close of 1913 Michigan has produced 5,361,432,892 pounds of copper, or 28.43 per cent of the output from the United States since 1845. For many years subsequent to 1845 Michigan was the most important copper-producing State, and in total output it is second only to Montana. The entire output is from the Keweenaw or Lake Superior district.

In the value of metal output, in the profits resulting from this output, in the development of mining and metallurgical processes, and in the general high standing of the companies conducting the operations, the district takes high rank among the great mining camps of the world. Prior to the perfection of the electrolytic process of refining, "Lake" copper enjoyed the distinction of being the highest grade produced, and even to the present time it sells at a figure slightly higher than the copper from other districts.

Although the district has been an active producer for 65 years, most of the older mines still have large reserves of ore and new mines are being opened, while much territory remains to be prospected. Moreover, it is claimed that a large tonnage of the mill tailings produced when milling methods were less efficient than at present can be retreated at a profit.

The more important new developments during the last few years have been made in the southern part of the district, and active development was continued in this section during the first half of 1913. The lodes in this section are apparently more "bunchy" than those farther north, but prospects of developing payable deposits in addition to those already producing are promising.

The Lake Superior region is unique in being the only district from which a large output is derived from native copper. The rocks [2] of

[1] Ransome, F. L., and Calkins, F. C., The geology and ore deposits of the Coeur d'Alene district, Idaho: U. S. Geol. Survey Prof. Paper 62, pp. 150–152, 1908; Calkins, F. C., and Jones, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: U. S. Geol. Survey Bull. 540, pp. 167–211, 1914.

[2] For detailed description of the geology and mining see Irving, R. D., U. S. Geol. Survey Mon. 5, 1883; Michigan Geol. Survey, vols. 5 and 6; Rickard, Eng. and Min. Jour., vol. 88; Pumpelly, Raphael, Michigan Geol. Survey, vol. 1, 1873; Lane, A. C., and Hubbard, L. L., Michigan Geol. Survey, vol. 4; 1898; Rominger, C., Michigan Geol. Survey, vol. 5, 1905; Rice, C. T., Copper Mining at Lake Superior: Eng. and Min. Jour., vol. 94, pp. 119, 171, 217, 307, 365; Hore, R. S., Mineral Resources of Michigan: Mich. Geol. and Biol. Survey, pp. 15–115, 1911; Van Hise, C. R., and Leith, C. K., The Geology of the Lake Superior region: U. S. Geol. Survey Mon. 52, pp. 573–591, 1911.

the district comprise a thick series of rather basic lava flows and intercalated beds of conglomerate and sandstone of pre-Cambrian age. These have been tilted so that they have a northwest dip, usually rather steep, and strike in a general northeast-southwest direction. The copper occurs in the cellular portion of the lava flows, which form the amygdaloid lodes, and as a cement and to some extent a replacement of the conglomerate pebbles forming the conglomerate lodes. Copper also occurs in fissures crossing the formations, but at present these are of little commercial importance, though in the early days of the district considerable copper was derived from this type of deposit. A little native silver occurs with the copper. The lodes are of low grade, but characterized by great extent and rather uniform distribution of the metallic content. This, together with the fact that the ore is susceptible of high concentration with low cost of refining the resultant "mineral," makes it possible to work these low-grade deposits at a good profit. The native copper occurs in the lodes in masses varying from microscopic size to bodies weighing hundreds of tons. The richest lode mined at present yields less than 1.5 per cent copper, and the poorest rock treated yields but little above five-tenths of 1 per cent of metal. For this low-grade ore to be profitable it must be handled on a large scale; this has resulted in the construction of the immense plants that characterize the Lake district. The lodes are worked for the most part through inclined shafts, though some of the deeper deposits are opened by vertical shafts. The workings have been extended in some cases to a mile in vertical depth, or about a mile and a half down the lode. Pillars of rock are left to keep the lodes open, and dry walls constructed from the waste sorted underground serve the same purpose in some of the mines. Much timber, however, is required in some of the mines, especially those operating on the conglomerate lodes.

The rock coming from the mines is crushed by steam stamps and concentrated, producing "mineral" containing an average of about 65 per cent copper. In recent years regrinding plants have been constructed for the finer grinding and concentration of material that had previously been discarded as tailings. The "mineral" is subjected to a combined smelting and refining process. A small amount of "mass" and "barrel work" copper are sorted out at the mine and go direct to the smelter. A portion of the output is refined electrolytically; this consists of copper sufficiently argentiferous to make the recovery of silver profitable, and of copper containing so high a percentage of impurities that further refining is necessary for certain uses. During 1913, 23.7 per cent of the output was refined electrolytically.

Silver in important quantity is recovered only from the copper treated electrolytically. The average recovery per ton of rock from which the copper was refined electrolytically was approximately 0.166 fine ounce.

In the following table is given the production of individual companies compiled from their annual reports, together with the cost of production and the price received for the copper.

The average cost for mines reporting was 13.44 cents a pound. The average cost of production in 1913 was abnormally high on account of the strike conditions, as is readily apparent on comparison with the cost of 10.28 cents a pound in 1912.

Production of copper by Michigan mines for 1912 and 1913, in pounds, compiled from the annual reports of the producing companies.[a]

Company.	1912	1913	Cost per pound, 1913.	Price received per pound, 1913.	Profit (+) or loss (−) 1913.
	Pounds.	*Pounds.*	*Cents.*	*Cents.*	*Cts. per lb.*
Ahmeek	16,455,769	9,220,874	13.30	15.41	+2.11
Allouez	5,525,455	4,091,129	12.09	15.627	+3.537
Atlantic	.....	44,370	.....	14.89	.....
Baltic	13,373,961	7,736,124	11.91	14.89	+2.98
Calumet & Hecla	67,856,429	45,016,890	14.25	15.77	+1.52
Centennial	1,742,338	1,612,262	13.38	15.301	+1.921
Champion	17,225,508	12,080,594	10.71	14.89	+4.18
Franklin	1,710,651	1,021,440	.....	15.427	.....
Isle Royale	8,186,957	4,158,548	18.81	15.27	−3.54
Lake	.....	287,200	.....	15.074	.....
La Salle	.....	43,906	.....	15.0	.....
Mass	2,045,006	1,213,545	.....	15.60	.....
Mohawk	11,995,508	5,778,235	13.22	15.36	+2.14
Osceola	18,413,387	11,325,010	12.30	15.48	+3.18
Quincy	20,634,800	12,184,128	.....	.....	.....
Superior	3,921,974	2,992,765	12.86	15.32	+2.46
Tamarack	7,908,745	4,168,743	16.60	15.42	−1.18
Trimountain	6,980,713	4,990,938	12.62	14.89	+2.27
Victoria	1,224,911	1,428,093	.....	.....	.....
Winona	2,307,237	1,448,737	.....	15.40	.....
Wolverine	8,350,312	.....	.....	.....	.....
Average[b]	.....	.....	13.44	15.44	+2.00

[a] Since this table includes mines reporting their output both for the calendar and for the fiscal years, and since some of the companies report the refined copper equivalent of mineral produced and others report refined copper, the totals do not necessarily agree with the total of either mine or smelter output.

[b] Average includes only mine whose reports are for the calendar year.

The average copper yield per ton of rock milled during 1913 was 19.4 pounds, as compared with 19.1 for 1912. The average copper recovery from conglomerate rock for 1913 was 30.1 pounds per ton and for amygdaloid 16.8 pounds per ton. The copper derived from the two types, respectively, was 29.7 and 70.3 per cent.

During 1913 the rock milled amounted to 7,016,370 tons, as compared with 11,411,941 tons for 1912.

The change in grade of ore handled by the Lake companies is shown in the following table. The figures are compiled from the annual reports of the companies.

Tonnage and yield of ore milled by Michigan copper companies in 1912 and 1913, compiled from the annual reports of the producing companies.

Company.	1912		1913	
	Tonnage.	Yield per ton.	Tonnage.	Yield per ton.
		Pounds.		*Pounds.*
Ahmeek	652,260	25.2	383,749	24.0
Allouez	333,618	16.56	236,663	17.29
Baltic	652,433	20.50	333,289	23.21
Calumet & Hecla	2,806,610	24.18	2,035,625	22.11
Centennial	106,517	16.36	85,443	18.87
Champion	765,306	22.51	421,849	28.64
Franklin	176,462	9.80	123,179	8.29
Isle Royale	531,105	15.4	314,679	13.2
Lake	.....	.....	19,211	14.95
La Salle	.....	.....	2,221	19.76
Mass	132,891	15.39	78,250	15.51
Mohawk	787,941	15.22	366,458	15.76
Osceola	1,246,557	14.8	735,044	15.4
Quincy	1,309,253	15.76	.....	.....
Superior	172,322	22.76	130,826	22.87
Tamarack	421,385	18.8	227,563	18.3
Trimountain	366,663	19.04	229,149	21.78
Victoria	131,955	9.28	137,163	10.42
Winona	181,148	12.7367	120,806	11.99
Wolverine	388,502	21.49	.....	.....

The district is well located for cheap working of the mines. The Great Lakes furnish cheap transportation for both coal and copper, the Lake transportation being brought into the heart of the district by Portage Lake and the Houghton ship canal. The district is served by the Mineral Range, Copper Range, and Keweenaw Central railroads and is connected with the main lines of traffic by the Chicago, Milwaukee & St. Paul and the South Shore & Atlantic railroads.

MONTANA.

The output of blister copper from Montana in 1913 was 285,719,918 pounds, as compared with 308,770,826 pounds in 1912. The State ranks second in copper production.

The first record of production of copper from Montana is for 1868, but the State did not become an important contributor of this metal until 1880. Since that time there has been a steady and rapid increase in the copper output. To the close of 1913 the State has yielded 6,192,744,628 pounds, or 32.84 per cent of the total output of the United States since 1845. In total production the State ranks first and in the output for 1913 it ranked second. The Butte district has furnished nearly the entire output.

Three copper-smelting plants were operated in Montana in 1913: The smelter of the East Butte Mining Co., at Butte, and the smelters of the Anaconda Copper Co., at Anaconda and at Great Falls.

Butte district.—In 1913 the Butte district, Silver Bow County, produced about 283,600,000 pounds of copper, or about 23.16 per cent of the total output of the country.

The presence of copper minerals in the district has been known since the discovery of gold in 1864, and attempts were made to treat the ores as early as 1866; but it was not until the late seventies that Butte began to attract attention as a copper camp, and large production did not begin until a railroad reached the district in 1881. To the close of 1913 Butte has produced about 6,177,800,000 pounds of copper, or 32.76 per cent of the total output of the country since 1845. In total production and in the output for 1913 it ranks first among the copper-producing districts of the United States.

The copper ores [1] of the district occur as replacement veins in a granitic rock known technically as quartz monzonite. These veins form complex systems of slightly different ages.

The principal original ore minerals in the copper veins are pyrite, enargite, bornite, chalcocite,[2] chalcopyrite, with varying quantities of sphalerite. It had been generally considered that the commercial ore has resulted from the processes of enrichment and that the material produced by the original mineralization was too low in copper content to be of commercial importance; but more recently many geologists have considered that all the ore minerals in the deeper levels are of primary origin, that is, that they were deposited from ascending solutions and that only the upper part of the deposit has been exten-

[1] Weed, W. H., Geology and ore deposits of the Butte district, Montana: U. S. Geol. Survey Prof. Paper 74, 1912; Kirk, C. T., Conditions of mineralization in the copper veins of Butte, Mont.: Econ. Geology, vol. 7, p. 35; Sales, Reno H., Ore deposits at Butte, Mont.: Am. Inst. Min. Eng. Bull., August, 1913; Bard, D. C., and Gilbert, M. H., Mineral associations at Butte, Mont.: Am. Inst. Min. Eng. Bull., August, 1913; Dunshee, B. H., Timbering at Butte, Mont.: Am. Inst. Min. Eng. Bull., August, 1913; Ingalls, R. W., Recent observations in Butte and Anaconda: Eng. and Min. Jour., vol. 97, pp. 937-943, 1914; Ray, J. C., Paragenesis of the ore minerals in the Butte district, Mont.: Econ. Geology, vol. 9, pp. 463-481.

[2] Sales, R. H., Econ. Geology, vol. 5, p. 681, 1910; Graton, L. C., and Murdoch, Joseph, The sulphide ores of copper: Am. Inst. Min. Eng. Bull. 77, p. 767, May, 1913.

sively effected by changes resulting from descending solutions. The ores may be divided into two general classes as regards treatment—the sulphide-quartz smelting ores and the concentrating ores consisting of altered quartz monzonite impregnated with grain and veinlets of sulphide.

The grade of ore mined in the district is regulated to a considerable degree by the possibility of profitable treatment. An increase in the price of copper or a decrease in the cost of mining and treatment permits the mining of lower grade ores. In 1913 the average yield was 2.70 per cent copper, as compared with 3.02 per cent in 1912, with 3.17 per cent in 1911, and with 3.13 per cent in 1910. In 1913 smelting ores averaging 5.22 per cent copper furnished about 28 per cent of the output derived from ores, and concentrating ores averaging 2.239 per cent furnished about 72 per cent. The ores averaged 1.92 ounces silver and 0.0058 ounce gold per ton, the precious metal content reducing the cost of copper about 2.37 cents per pound.

The mines of the Anaconda Co. were operated without serious interruption throughout the year. The smelter at Anaconda was closed for 11 days in October in order to clean and repair the flues, and this together with severe weather conditions during January and February, and the treatment of some unusually low-grade ore, resulted in a considerable decrease in metal output.

A total of 35.3 miles of development work was accomplished and a tonnage of ore in excess of that extracted was added to the ore reserves.

A notable feature of the development work was the disclosing of a large vein of good grade of ore on the 3,000-foot level of the original mine. Two compartments of the high ore shaft were sunk to the 3,400-foot level. As soon as the other compartments have been raised to the 2,800-foot level development on the 3,000, 3,200, and 3,400 foot levels will be begun.

The systems of compressed air hoisting and electric haulage were further extended during the year.

The mines of the company produced during the year 4,644,201.24 tons of ore and 7,243.62 tons of precipitate, or a total of 4,651,444.86 tons:

The reduction works treated for all companies during the year 4,016,689.16 tons of ore and other cupriferous material at Anaconda, and 1,170,150.43 tons of ore and other cupriferous material at Great Falls. Of this 4,566,450.85 tons of ore from company mines, 619,864.03 tons of ore purchased from or treated for other companies, and 524.71 tons of precipitates and cleanings from the old works were treated, from which there were produced 205,730,594 pounds of fine copper, 9,026,690.13 ounces of silver, and 53,934.869 ounces of gold at Anaconda; and 64,571,050 pounds of fine copper, 1,294,606.08 ounces of silver, and 10,963.565 ounces of gold at Great Falls, or a total production of 270,301,644 pounds of fine copper, 10,321,296.21 ounces of silver, and 64,898.434 ounces of gold; of which total 241,983,323 pounds of fine copper, 8,719,132.54 ounces of silver, and 64,898.434 ounces of gold were produced by the Anaconda Co.

At the Anaconda plant the erection of a round-table plant capable of treating 2,000 tons of slime material per day was begun. It is expected that the operation of this plant will produce about 300 tons of concentrates per day, which will yield about 1,000,000 pounds of

copper per month. The company also plans to erect a leaching plant capable of treating 2,000 tons daily of sand tailings and an 80-ton experimental plant for the leaching of slime tailings.

The new smelter at Great Falls was about half completed at the close of the year.

Profits for the year were $11,323,498.48, and dividends were paid to the amount of $12,997,500.

The mines and reduction plant of the East Butte Copper Co. were operated throughout the year. The company's mines produced 105,071 tons (wet weight) of ore, with an average assay content of 5.16 per cent copper. There were treated 101,924 tons of company ore and 84,891 tons of custom ore, or a total of 186,815 tons, which yielded 14,401,108 pounds of copper, 506,897 ounces silver, and 8,803 ounces gold. The average cost a pound of copper was 11.04 cents. The net surplus on operations is reported as $531,722.14. Developments were extended to the 1,500-foot level and are reported to be encouraging.

The North Butte mine produced during the year 462,799 wet tons of ore and 71 tons of precipitate. There were treated at the smelter 454,984 dry tons of ore and 45 dry tons of precipitate, of which 121,773 dry tons were first class and 333,211 tons were second class. This ore yielded 28,318,321 pounds of copper, 1,602,163.67 ounces silver, and 1,567.114 ounces gold.

The general manager reports that developments during the year kept the ore reserves at the same figure at which they stood January 1, 1913.

The Tuolumne Copper Mining Co. produced 34,276.5 tons of ore yielding 1,880,514 pounds of copper, 77,571.76 ounces of silver, and 140.4 ounces of gold.

The Butte & Duluth Co. operated its leaching plant on oxidized ores. The copper is precipitated from the solutions electrolytically and the resulting cathodes shipped East for further refining.

A small leaching plant was being constructed by the Bullwhacker Copper Co., which it is expected will be operated in 1914.

NEVADA.

The production of blister copper in Nevada in 1913 was 85,209,536 pounds, as compared with 83,413,900 pounds in 1912.

The earliest record of the production of copper in Nevada was for 1873, but it did not become an important factor in the copper industry until 1908, when production form the Ely district began.

To the close of 1913 the State has a recorded production of 372,123,548 pounds, or 1.98 per cent of the output of the country since 1845. To this should probably be added a small but unknown quantity produced as bluestone in the early days of mining in the State and used locally in the treatment of gold and silver ores. In total production Nevada ranks sixth, and in the output for 1913 fifth among the copper-producing States.

A large part of the output was from two districts, the Ely district, in White Pine County, and the Yerington district, in Lyon County.

Ely district.—The Ely district, White Pine County, was the largest producing district in the State in 1913. Although it has long been known that the district contained copper deposits, active development on an important scale began but a few years ago, and important

production did not begin until 1908, when the Steptoe Valley smelter and concentrating plant was completed.

During 1913 the district produced about 68,600,000 pounds of blister copper, and to the close of 1913 the output has been about 325,900,000 pounds. The district has yielded 1.73 per cent of the total output of the country since 1845, and it produced 5.60 per cent of the output in 1913. In total production it ranks ninth and in the production for 1913 seventh among the copper districts of the country.

The district is in the Egan Range, the geology [1] of which may be summarized as follows: Paleozoic limestones and shales have been invaded by a granitic intrusive technically known as quartz monzonite porphyry, probably of Mesozoic age. Later the area was buried beneath lava flows which have been in large part removed by erosion.

The copper ores are of two types, replacement deposits in the limestone, and disseminated deposits in the altered monzonite porphyry. The deposits in the limestone are near the quartz monzonite and are associated with garnet and other contact silicates and usually with abundant jasperoid. The deposits of this type thus far developed have been largely oxidized and to the present time there has been a relatively small production from them.

The disseminated ores are principally included in the monzonite porphyry area though they extend into the adjacent sediments to some extent. The monzonite porphyry has been much shattered and altered, the hornblende and feldspars of the monzonite being altered to orthoclase, quartz, sericite, and brown mica The metallic minerals of the primary ore, pyrite and chalcopyrite, occur as veinlets and disseminated grains in the altered rock. The commercial ore has resulted from the process of enrichment. In this enrichment the copper in the upper part of the deposit has been in part taken into solution and redeposited on the sulphides lower in the deposit, usually as chalcocite. The commercial ore consists of grains of pyrite and chalcopyrite partly or entirely replaced by chalcocite. The leached capping is of varying thickness, but for a part of the deposit it is thin enough to permit of its removal and the mining of the ores by steam shovel; for the remainder underground methods of mining are necessary.

For the Eureka section of the Nevada Consolidated Copper Co.'s area the average thickness of the capping is 87.1 feet, and of the profitable ore 190 feet; for the Hecla area the capping is of an average thickness of 101.4 feet and the ore is 280.3 feet thick; and for the Liberty area the capping is 154.7 feet thick and the ore 193.3 feet thick.

During the year 3,419,178 tons of copper ore mined in the district produced concentrates containing 69,950,850 pounds of copper. The average recovery in concentrates per ton of ore from the district was 1.02 per cent of copper, with about 13.4 cents in gold and silver per ton of ore. Smelting ores amounting to 28,532 tons contained 3.44 per cent of copper, with 47 cents in gold and silver per ton.

During the year the Nevada Consolidated Copper Co. developed 3,269,000 tons of ore with an average copper content of 1.42 per cent.

[1] Lawson, A. C., California Univ. Dept. Geology Bull. No. 4, p. 284; Spencer, A. C., U. S. Geol. Survey Bull. 529, p. 189, 1913.

The profitable ore in reserve December 31, 1913, is estimated as 39,108,590 tons with an average copper content of 1.65 per cent.

During the year the following tonnage of sulphide ore was mined and shipped to the concentrator:

Copper ore mined and shipped by Nevada Consolidated Copper Co. in 1913, in short tons.

	Quantity.	Per cent of copper
Eureka pit	1,543,456	.....
Liberty and Hecla pits	1,345,933	1.511
Veteran	258,896	2.588
Total	3,148,285	1.597

Siliceous carbonate ores amounting to 29,971 dry tons and averagint 3.28 per cent copper were mined, all of which were crushed and delivered to the smelter.

The following table shows the result of operations of the concentrator:

Operations of Nevada Consolidated Copper Co. for the year ending Dec. 31, 1913.

Ore treated (dry)	short tons	3,139,137
Average copper assay	per cent	1.599
Percentage of extraction (copper)	do	68.52
Ratio of concentration		6.94
Average value in gold	ounces	.013
Average value in silver	do	.034
Percentage of extraction (gold)	per cent	43.87
Percentage of extraction (silver)	do	57.83
Average gold and silver recovered per ton of ore	cents	12.32
Average copper in concentrates		7.61

The net profit of the year was $3,483,866.33. Dividends were paid to the amount of $2,999,185.49.

There were numerous improvements made in the concentrating and smelting plants during the year.

The yield from all ores mined and treated and from siliceous carbonate ores delivered to the smelter amounted to 64,972,829 pounds of copper for the year 1913. The total cost per pound of copper was 9.99 cents.

In May, 1913, the Consolidated Coppermines Co. was formed as a consolidation of several properties, including the old Coppermines Co., the Giroux, the Butte & Ely, and New Ely Central companies.

From June 1, 1913, to April 30, 1914, the Giroux Co. mined and shipped 170,298 wet tons of ore, and during the same period produced 3,041,678 pounds of copper, 2,212 ounces silver, and 1,061 ounces gold. The general manager, under date of June 1, 1914, estimates the following ore reserves:

Giroux—Fully developed 14,199,180 tons averaging 1.219 per cent copper. Partly developed 6,456,872 tons, averaging 1.041 per cent copper.

Old Coppermines—Partly developed 968,184 tons, averaging 1.01 per cent copper.

Total developed and partly developed 21,624,236 tons, averaging 1.153 per cent copper.

Yerington district.—The Yerington district produced 14,400,000 pounds of blister copper in 1913.

Copper ores have been mined in the district for many years. In the early days considerable natural bluestone was mined and used in the treatment of gold ores at Virginia City. Later an attempt was made to smelt the ores, but with little success. No accurate data of the total output of the district has been compiled, though it has not been large. During the last few years development of ore by several companies has been in progress, and it is reported that considerable ore carrying copper values of 3 per cent or better have been opened.

The ores of the district according to Ransome [1] are of three types of occurrence:

1. Irregular bodies formed by metasomatic replacement of limestone and genetically associated with metamorphism of a kind usually attributed to contact action of intrusive rocks: (2) metasomatic vein deposits in altered limestone; and (3) metasomatic vein deposits in granodiorite.

The most important developments are of ore bodies of the first type. The original sulphides of these are pyrite and chalcopyrite in various proportions, with a gangue of pyroxene, amphibole, epidote, garnet, and calcite.

The smelter of the Mason Valley Mines Co., Wabuska, was operated throughout the year. There were treated 227,855 tons of ore, of which 116,636 tons were from the mines of the company and 111,219 tons were custom ore. From these ores copper matte was produced containing 14,601,520 pounds of copper, 9,922 ounces gold, and 121,834 ounces silver.

Converters were added to the smelting plant during the year and placed in operation early in 1914.

The Nevada-Douglas Copper Co. was the only other large producer in the district. This company has under consideration the construction of a leaching plant for the treatment of its ores.

Other districts.—Other districts in the State that made production of copper were Goldfield, Pioche, and Santa Fe.

NEW MEXICO.

The production of blister copper from New Mexico in 1913 was 50,196,881 pounds, as compared with 29,170,400 pounds in 1912. The large increase was due to the larger production by the Chino Copper Co. of the Santa Rita district.

Production of copper from New Mexico began in the last years of the eighteenth century, native copper from the mines of Grant County being carried to Mexico City and coined into money. During the nineteenth century, however, there was but small output. A little copper is reported for about the year 1860, but New Mexico did not have a steady output until after 1880 and did not become an important factor in production until 1900.

From 1845 to 1913 New Mexico has a recorded output of 174,550,844 pounds of copper, or 0.93 per cent of the output of the country since 1845. The principal production has been from the districts in Grant County.

Santa Rita district.—The Santa Rita district, in Grant County, made a large increase in production in 1913, due to the operation of all five sections of the mill of the Chino Copper Co. for most of the year. This was probably the first district in the West from which

[1] Ransome, F. L., The Yerington district, Nevada: U. S. Geol. Survey Bull. 380, p. 99, 1909.

important copper production was made, the output beginning in the closing years of the eighteenth century and the metal going to Mexico for coinage. There are no accurate records of the production for this early period of operation, but from the best sources available it is estimated that the total production to the close of 1913 has been approximately 179,900,000 pounds.

The geology [1] of the district is rather complex. The sedimentary series, consisting of quartzite, shales, and limestone, has been invaded in post-Cretaceous time by granitic and porphyritic rocks of monzonitic and dioritic composition. After a period of erosion the area was buried beneath Tertiary volcanic flows, which in turn have been largely removed by erosion.

The copper deposits may be divided into two types—contact deposits and disseminated deposits. The contact deposits occur as replacement of limestone near the porphyry contact and have been most extensively worked in the Hanover end of the district.

In the disseminated deposits the ore minerals occur as small veins and grains of mineral in shattered quartzite and highly altered intrusives. Unlike many of the disseminated deposits, much of the copper occurs native and as the oxide, though chalcocite ores are also abundant. Prior to 1912 the main production came from shallow workings, following high-grade streaks of native copper, and from oxide and chalcocite ores.

Since 1909 the Chino Copper Co. has been actively developing the main mineralized area by means of churn drills, and production by this company began late in 1911. The management gave the developed ore at the close of 1913 as over 90,000,000 tons, of an average grade of about 1.8 per cent copper.

It is stated that nearly 90 per cent of the developed ore can be extracted by steam-shovel methods, and a part of the area has already been stripped and is being mined by this method.

During the year 1,942,700 tons of ore were treated at the mill. The average copper content of the ore was 2.033 per cent and the average recovery of copper contained in concentrates was 67.31 per cent of the copper contained in the ore.

The total production for the year of copper in concentrates was 53,170,145 pounds, the average grade of concentrates being 14.518 per cent copper and the ratio of concentrates 10.61 tons into 1. The net production of copper was 50,511,661 pounds. The average cost of producing copper for the year was 8.787 cents per pound.

The net income of the company for the year was $3,234,033.51. The payment of dividends was inaugurated June 30, 1913, and to the close of the year three quarterly dividends, amounting to $1,919,070, were paid.

The concentrates are shipped to the El Paso smelter for treatment. The district is served by a branch line of the Santa Fe Railway connecting with the main line and with the Southern Pacific at Deming.

Burro Mountain district.—The Burro Mountain district, southwest of Silver City, made but a small production in 1913. The total production from the district has probably been about 10,000,000 pounds of copper.

[1] Lindgren, Waldemar, Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: U. S. Geol. Survey Prof. Paper 68, p. 305, 1910; Paige, Sidney, The geologic and structural relations at Santa Rita (Chino), N. Mex.: Econ. Geology, vol. 7, p. 547.

The Burro Mountain [1] consists of a pre-Cambrian complex that has been intruded by monzonite porphyry. The copper ores occur mainly as impregnations and replacements along irregular fractures and zones of crushing. The primary sulphide is cupriferous pyrite, but the workable deposits have resulted from the enrichment of the primary ores.

The operations of the Burro Mountain Copper Co., controlled by Phelps, Dodge & Co., were confined principally to preparations for extraction and milling of ore, though some ore was developed. It is planned to construct a 1,000-ton concentrator for the treatment of the ores from the company's mines.

The Lordsburg district was the only other important contributer to the copper production of the State.

TENNESSEE.

The production of blister copper from Tennessee in 1913 was 19,489,654 pounds, as compared with 18,395,256 pounds in 1912.

The entire output was from the Ducktown district, located in the extreme southeastern part of the State, in Polk County. The district was one of the earliest large producers in the country. Operations began about 1850, and from that date till the close of the Civil War there was a large production from the "black-copper" ores. With the exhaustion of the rich secondary deposits attempts were made to work the lean original sulphides. These efforts met with only indifferent success, and in the late seventies the smelters shut down, thus ending the first period of activity in this district. The present period of activity began in 1890, when the Ducktown Sulphur, Copper & Iron Co. began operations. Since that time the district has been a steady producer from the primary sulphide ores. To the close of 1913 the total output of the district has been approximately 268,544,000 pounds.

The ores [2] occur as steeply dipping lenses replacing calcareous in schist, the ore bodies in general conforming to the dip and strike of the schistosity of the inclosing rock. The principal sulphide is pyrrhotite, with subordinate pyrite, chalcopyrite, and sphalerite. Extensive gossans capped the ore bodies, and it was the enriched zones underlying these that furnished the rich chalcocite ores that were extracted during the first period of activity.

In 1913 the ores of the district yielded 29.73 pounds of blister copper per ton, or 1.476 per cent, with an average value of 11.2 cents in gold and silver per ton of ore. A part of the copper is marketed without electrolytic refining. The fact that the ores can be extracted with little timbering, the cheap supply of coke and coal from Tennessee and West Virginia, and the comparatively low cost of labor, have made it possible to mine and treat these low-grade ores at a profit.

---

[1] Lindgren, W., Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: U. S. Geol. Survey Prof. Paper 68, p. 321, 1910; Paige, Sidney, Metalliferous ore deposits near the Burro Mountains, Grant County, N. Mex.: U. S. Geol. Survey Bull. 470, p. 131, 1911.

[2] The deposits have been described by Heinrich, Carl, Am. Inst. Min. Eng. Trans., vol. 25, p.173; Weed, W. H., idem, vol. 30, p. 452; Kemp, J. F., idem, vol. 31, p. 224; Higgins, E., Eng. and Min. Jour., vol. 86, pp. 1237–1241, 1908; Channing, J. P., Min. and Sci. Press, vol. 96, p. 97, 1908; Gottsberger, B. B., Mining World, vol. 29, pp. 911–914, 1908; Weed, W. H., Ore deposits of the Appalachian States: U. S. Geol. Survey Bull. 455, p. 152, 1911; Laney, F. B., The manufacture of sulphuric acid from smelter fumes at Ducktown, Tenn.: U. S. Geol. Survey Mineral Resources, 1911, pt. 2, 1912.

The pyritic process of smelting is practiced successfully by both companies. The low-grade matte produced by the first smelting is resmelted and brought to a proper grade for conversion.

Sulphuric-acid plants were operated by both the Ducktown Sulphur, Copper & Iron Co. and the Tennessee Copper Co. The successful operation of these plants has apparently not only solved the troublesome smelter-smoke problem, but added very materially to the revenue of the companies. The sulphuric-acid production will probably be fully as important in the future as the copper output.

The Tennessee Copper Co. produced 470,135 tons of ore from the district, which yielded 13,493,140 pounds of copper, or an average of 28.7 pounds per ton of ore. The average cost of the production of copper was 11.34 cents per pound.

The production of sulphuric acid for the year by the Tennessee Copper Co. was 197,712 tons 60° Baumé.

The company estimates ore reserves as practically unchanged from 1912 when they were estimated as follows: Available ore, 3,691,000 tons; probable ore, 1,380,000 tons, or a total ore reserve of 5,071,000 tons.

Net profits for the year were $1,087,503.06. Dividends were paid to the amount of $570,800.

The district is served by a branch line of the Louisville & Nashville Railroad, the mines and smelters of the companies being connected with this by private lines.

UTAH.

In 1913 Utah produced 148,057,450 pounds of blister copper, as compared with 132,150,052 pounds in 1912. The smaller production for 1912 was caused by labor troubles in the camp during that year.

The first record of production of copper from Utah is for 1872. The State did not become an important copper producer, however, until late in the nineties, since which time the growth of the industry has been steady and rapid. The total recorded output from the State to the close of 1913 has been 1,081,322,177 pounds, 5.73 per cent of the output of the United States since 1845. In 1913 Utah produced 12.09 per cent of the output. In total output and in the production for 1913 it ranks fourth among the copper-producing States.

Two copper-smelting plants were operated in the State during 1913, the Garfield smelter at Garfield, and the International smelter at Tooele.

Bingham district.—The Bingham or West Mountain district, Salt Lake County, produced about 132,000,000 pounds of blister copper in 1913, as compared with about 112,000,000 pounds in 1912. As noted in the 1912 report, labor troubles resulted in a greatly reduced output for that year.

The presence of copper minerals has been known since the early days of mining in the district, but for many years operations were confined to the production of lead, silver, and gold. Not until 1896 did the mining of copper ore become of commercial importance. To the close of 1913 the district has produced approximately 834,500,000 pounds, or 4.43 per cent of the output of the country since 1845. For 1913 the district yielded 10.78 per cent of the total production.

In total output the district ranks fifth among those of the country and in the production for 1913 it ranks fourth.

The ore deposits of the district[1] are closely associated with masses of monzonite porphyry intruded into a series of quartzites with intercalated beds of limestone and shale of Carboniferous age. The copper ores are of two types of occurrence—as irregular replacement deposits of limestone, and as disseminated deposits through altered porphyry and quartzite.

In the early years of production most of the copper from the district was derived from the replacement deposits in limestone. These are massive bodies of pyrite carrying chalcopyrite in varying amounts and in places grading into ores carrying galena and sphalerite in important amounts. They occur as replacements of the limestone associated with fissures and usually not far from bodies of monzonite porphyry. Enrichment has not extended to great depth in this type of deposit and the enriched ores have been largely extracted. The ores vary greatly in copper content and consequently the average percentage derived for a given year depends largely on the grade that can be worked at a profit at the price of copper. In 1913 the ores yielded about 1.78 per cent copper and rather high values in gold and silver. About 490,000 tons of this type of ore was produced during the year, yielding about 16,990,000 pounds of copper.

The primary mineralization of the disseminated type of ore consists of grains and veinlets of pyrite and chalcopyrite disseminated through shattered and altered monzonite porphyry and quartzite. The varying intensity of alteration of the monzonite porphyry has yielded different gangue minerals in different parts of the disseminated ore body, forming what is designated as "dark porphyry" and "light porphyry."

In the "dark porphyry," the hornblende and augite of the monzonite have been altered to brown mica, while the plagioclase feldspar has been altered in part to sericite and in part to secondary orthoclase. The abundant brown mica gives the rock a dark color. In the "light porphyry" the lime and magnesia have been largely removed and there has been a marked addition of potassium resulting in a rock composed essentially of quartz, secondary orthoclase, and sericite together with the metallic sulphides.

The commercial ore is the result of enrichment, the copper content of the upper portion of the deposit having been in part taken into solution and redeposited on the sulphides at greater depth. These secondary sulphides include both covellite and chalcocite. As contrasted with many similar deposits covellite is relatively abundant as a secondary sulphide. Secondary sulphides are relatively less abundant in the Bingham disseminated ores than in several similar deposits. The commercial ore body is an irregular layer covered by the leached and partly leached "capping" and underlain by the lean primary ore. The average thickness of the commercial ore as shown by the developments of the Utah Copper Co. to the close of 1913, is 444.5 feet. The thickness of the "capping" varies greatly at different points. As determined at the close of 1913 the average thickness over the entire ore body is 114 feet. The disseminated ores are

[1] For detailed information see Boutwell, J. M., Economic geology of the Bingham mining district, Utah: U. S. Geol. Survey Prof. Paper 38, 1905.

extracted by both steam-shovel and underground methods. During the year about 8,300,000 tons of disseminated ore was mined in the district, yielding about 0.75 per cent of copper in concentrates, and small amounts per ton in gold and silver.

The ores were treated at the mills at Garfield and at the Ohio Copper Co.'s mill at Lark. The ores and concentrates from the district were reduced at the Garfield smelter and the International smelter. The mills of the Utah Copper Co. treated 7,519,392 tons of ore, with an average copper content of 1.25 per cent. The average recovery was 63.95 per cent, equivalent to 15.95 pounds of copper per ton of ore treated. The total production in concentrates for the year by the Utah Copper Co. was 119,939,809 pounds, or, after making deduction for loss in smelting, a net production equivalent to 113,942,834 pounds of refined copper. In addition to the copper there were produced 28,121 ounces of gold and 285,589 ounces of silver. The average cost of producing this copper was 9.498 cents per pound.

At the close of 1913 development had been carried on over an area of 225.31 acres and ore estimated at 361,220,234 tons, with an average copper content of 1.47 per cent, had been developed and partly developed. Of this ore 28,720,234 tons, with an average copper content of 1.465 per cent, had been extracted prior to January 1, 1914, leaving ore reserves at that date of 332,500,000 tons, averaging 1.47 per cent copper.

The combined capacity of the company's mills at Garfield is 21,000 tons a day of average ore, but when operating on low-grade ore they have treated at the rate of 24,000 tons a day.

Operations were carried on at the mine and mill of the Ohio Copper Co. throughout the year. For the first five months of the year the copper content of the ore averaged 1.015 per cent.

The Utah Consolidated Mining Co. shipped 181,077 tons of copper ore, averaging 1.987 per cent copper and 0.056 ounce of gold and 0.705 ounce of silver per ton. At the close of the year there was reported as in sight in the mine 287,038 tons of copper ore, averaging 1.90 per cent copper and 0.05 ounce of gold and 0.70 ounce of silver per ton. The ores were shipped over the aerial tram to the International smelter.

Several other companies in the district were important producers of copper and copper-lead ores, notably the Old Jordan mine of the United States Mining Co.

The district is served by a branch of the Denver & Rio Grande Railroad and the Bingham & Garfield Railway, controlled by Utah Copper Co. interests, connecting the mines at Bingham with the mills at Garfield. Cable tramways are employed to considerable extent; the ores from the Utah Consolidated mines are delivered to the International smelter in this manner, and ores from other mines are delivered to the railroad over cable tramways.

Tintic district.—The Tintic district in Juab County made a production of about 9,250,000 pounds of blister copper in 1913, as compared with about 13,000,000 pounds in 1912. The production of copper from the Tintic district is largely incidental to the production of other metals. The quantity of ore in which copper is the most important metal constituent is relatively small. There has been a

small output of copper from the district for many years, but no accurate statistics of the early output are available. It is estimated that to the close of 1913 the district has yielded approximately 113,150,000 pounds of copper.

The occurrence of the ores[1] may be briefly summarized as follows:

The sedimentary series, consisting of limestone and quartzite, has been intruded by an extensive mass of monzonite. The ores occur as replacement deposits in the limestone near the monzonite contact, as replacement veins in the igneous rocks, and as replacement veins in the sedimentary series.

The most valuable deposits developed are of the last-named type. The fissures are usually nearly vertical, and the replacement bodies are extremely irregular in form and variable in size. The original minerals were pyrite, galena, sphalerite, and enargite, with rich silver and gold minerals in a gangue of quartz and barite.

There has been little development below the water level, which is usually below 1,600 feet in the deposits in limestone, and oxidation to this point has been rather complete. Recent developments below the water level in some of the mines have been encouraging.

The Centennial-Eureka mine was the most important producer of copper in 1913, as in previous years, though important production was made by the Gold Chain, Mammoth, Grand Central, Opohongo, and a lesser production by other mines.

Frisco district.—The Frisco district of Beaver County made a production of about 3,000,000 pounds of copper in 1913, as in 1912.

The first important production of copper from this district was from the Horn silver mine in 1889, and since that time there has been a production of copper from lead-silver ores and from small copper mines. The importance of the district as a copper camp dates from the starting of the mill in 1905 to treat ores of the Cactus mine. To the close of 1913 the district has yielded approximately 38,600,000 pounds of copper.

During 1913, as in previous years, the Cactus mine was the largest producer of copper, but important production was made by the Old Hickory mine of the Majestic Mines Co., and other mines in the Frisco area contributed also to the copper output.

The ores[2] of the area are of several types. Those of the Cactus mine consist of pyrite and chalcopyrite, disseminated in a highly brecciated and altered area of quartz monzonite. Most of the ore is of low grade and requires concentration before shipping. The company's 1,000-ton mill was operated in 1913, but was shut down early in 1914. Concentrates were shipped to the International smelter for treatment.

The ores of the Old Hickory mine are replacement deposits in limestone at the contact of quartz monzonite. The ores have a high iron content, being composed largely of magnetite.

Other mines in the area made smaller outputs of copper from copper and mixed ores.

Other districts of the State that contributed in important degree to the copper output were the Lucien, Ophir, Rush Valley, Park City, Snake Creek, and Little Cottonwood districts.

---

[1] For detailed report, see Tower, G. W., and Smith, G. O., U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, pp. 601–767, 1899.

[2] For detailed description of the ore deposits, see Butler, B. S., Geology and ore deposits of the San Francisco and adjacent districts, Utah: U. S. Geol. Survey Prof. Paper 80, 1913.

OTHER STATES.

Missouri.—Missouri produced 576,204 pounds of copper in 1913, as compared with 440,725 pounds in 1912. The output is mainly recovered as a by-product in the dressing of lead ores.

Oregon.—Oregon produced 77,812 pounds of copper in 1913, as compared with 311,860 pounds in 1912. To the close of 1913 the State has a recorded output of 2,965,399 pounds. The largest production in recent years has been from the Waldo district in Grant County.

Pennsylvania.—Pennsylvania produced 245,337 pounds of blister copper in 1913, as compared with 248,378 pounds in 1912. The copper is recovered as a by-product in the treatment of pyritiferous magnetite at the Cornwall mines, Lebanon County.

Virginia.—Virginia produced 46,961 pounds of copper in 1913.

Washington.—Washington produced 732,742 pounds of blister copper in 1913, as compared with 1,069,938 pounds in 1912. The State contains no important producing district, the total recorded output to the close of 1913 being but 3,975,964 pounds.

The Tacoma smelter was operated principally on ores from outside the State.

REFINERY PRODUCTION.

The refinery output of the United States was made by 13 plants, 9 of which employ the electrolytic method and 5 employ the furnace process on Lake Superior copper, the Buffalo plant employing both the electrolytic and the furnace refining method. Six of the large electrolytic refineries are located on the Atlantic tidewater, 5 Lake refineries are on the Great Lakes—4 in Michigan and 1 in New York. Only 2 plants are located west of the Great Lakes—1 at Great Falls, Mont., and 1 at Tacoma, Wash. In addition to these refineries, there are numerous plants in different parts of the country that make a considerable output from old copper, brass, and other alloys of copper. The output of the regular refining plants is in the form of casting. Lake, and electrolytic copper.

CASTING AND PIG COPPER.

Bister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and ordinarily cast into ingots. This copper is usually unfit for the uses requiring a high-grade copper, such as electric transmission, brass manufacture, and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries such low values in precious metals that, together with the value added to the copper by electrolytic refining, these values will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is small. Some blister or pig copper low in precious metals is exported without further treatment and is probably consumed without electrolytic refining. A large percentage of the casting copper, shown in the table, is from the Morenci-Metcalf district, Arizona. The pig copper is from this district and the Ducktown, Tenn., district. Both districts produce a rather high grade of blister carrying low values in precious metals, and it is found profitable to market much

of it without electrolytic refining. During 1913 the production of new casting copper amounted to 22,606,040 pounds, and pig copper amounted to 36,004,986 pounds.

LAKE COPPER.

By Lake copper as used in this report is meant the output of the Lake smelters. A considerable portion of this output is refined electrolytically, but most of the electrolytically refined Lake copper is mixed with furnace-refined copper or sold as some brand of Lake copper. Of the 155,715,286 pounds of copper produced by the Lake smelters, about 36,997,000 pounds were refined electrolytically, either to free it from impurities or to recover the silver content.

ELECTROLYTIC COPPER.

Under electrolytic copper, as shown in the accompanying table, is included all new copper that was refined electrolytically, except that from the Lake district. In 1913 the production of electrolytic copper from primary materials of domestic origin amounted to approximately 1,022,497,000 [1] pounds and that of foreign origin to 378,243,000 pounds. Electrolytic copper to the amount of 14,862,577 pounds was produced from secondary sources, making a total electrolytic production of 1,629,930,359 pounds for the year.

SECONDARY COPPER.

Under secondary copper is considered material recovered from remelting old copper, copper scraps, etc., and copper recovered from the treatment of copper alloys or alloys that are treated without the separation of the copper. A careful canvass of plants producing secondary copper has been made by J. P. Dunlop, of the United States Geological Survey. Concerning the output of secondary copper Mr. Dunlop states:

> The total quantity of secondary copper recovered in 1913, on the assumption that the brass remelted had an average copper content of 70 per cent, was 273,000,000 pounds, of which 37,322,000 pounds (about 8,000,000 pounds more than in 1912) was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by smelters of the latter class includes 73,432,000 pounds of pig copper, 23,206,000 pounds of copper in alloys other than brass, and 139,040,000 pounds of copper in remelted brass. These figures indicate a decrease for 1913 of about 12,000,000 pounds of pig copper and 3,000,000 pounds of copper in brass and an increase of about 4,600,000 pounds in alloys other than brass. At least 90,000,000 pounds was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that only about 183,000,000 pounds was obtained from ashes, cinders, and scrap, or from material that had actually been used and discarded. The value of the copper, both as metal and in alloys, is computed at the average yearly price quoted for casting copper by the American Metal Market. According to the Bureau of Foreign and Domestic Commerce, the exports of scrap brass fit only for remanufacture for the calendar year 1913 were 21,886,000 pounds, and the imports were 6,790,000 pounds. Many railways sell or turn in the larger portion of their brass and copper scrap and other metal waste to dealers in part payment for new material, but the reports received show that the railways utilized in their own shops and foundries over 25,340,000 pounds of brass, in addition to 1,800,000 pounds of copper and 5,656,000 pounds of copper in alloys other than brass.
>
> The production of copper from secondary sources in 1913 was equal to about 17 per cent of the refinery output of primary copper in the United States from all sources, or about 22.4 per cent of the primary copper smelted from domestic ore.

[1] The separation of refined copper into that of foreign and domestic origin is only approximate.

As contrasted with lead and zinc, the uses for which copper is principally employed are such that a large percentage of the metal can be eventually recovered and returned to the trade. The period elapsing between the time when copper enters the trade and is returned as scrap varies, of course, greatly with the uses for which it is employed, and no data are available that will give even an approximation of this period. However long this period may be, it is evident that there will be an increase in the production of copper from secondary sources proportionate to the great increase in the consumption of copper.

REFINED COPPER.

The total production of new refined copper in 1913 was 1,615,067,782 pounds, the largest output in the history of the industry, exceeding that of 1912 by 46,963,304 pounds.

The production of electrolytic, Lake, casting, and pig copper from primary sources and the production of secondary copper by the regular refining plants in 1912 and 1913 is shown in the following table:

Production of primary and secondary copper by the regular refining plants in 1912 and 1913, in pounds.

	1912		1913	
	Domestic.	Foreign.	Domestic.	Foreign.
Primary:				
Electrolytic	914,935,371	360,000,000	1,022,497,601	378,243,869
Lake	231,112,228	.....	155,715,286	.....
Casting	24,777,266	.....	22,606,040	.....
Pig	32,852,030	4,427,583	36,004,986	.....
Total primary	[a] 1,203,676,895	[a] 364,427,583	1,236,823,913	378,243,869
	1,568,104,478		1,615,067,782	
Secondary:				
Electrolytic	23,932,166		14,862,577	
Casting	5,150,137		22,360,182	
Total secondary	29,082,303		37,222,759	
Total output	1,597,186,781		1,652,290,541	

[a] The distribution of refined copper of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.

The figures for Lake copper include the Michigan copper that was electrolytically treated.

In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively produced a total of 235,000,000 pounds of copper as copper and in brass and other alloys of copper, making a total production of 273,000,000 pounds from secondary sources. Of this total at least 90,000,000 pounds was produced by remelting clean scrap produced in the process of manufacture of copper and brass articles.

If the output of plants treating purely secondary material is added to the production of the regular refining companies, the contribution of domestic plants of the United States to the world's supply of copper for 1913 is found to be 1,888,000,000 pounds.

During 1913 reports were made by the Copper Producers' Association of the monthly output of marketable copper by the regular

refining plants in the United States. The following table shows the output by months and the total for the year:

Monthly output of marketable copper in 1913, as reported by the Copper Producers' Association.

	Pounds.		Pounds.
January	143,479,625	August	131,632,362
February	130,948,881	September	131,401,229
March	136,251,849	October	139,070,481
April	135,353,402	November	134,087,708
May	141,319,416	December	138,990,421
June	121,860,853		
July	138,074,602	Total	1,622,450,829

COPPER SULPHATE.

The production of hydrous copper sulphate or bluestone by the refineries of the United States in 1913 was 34,270,478 pounds, having a copper content of about 8,567,620 pounds, as compared with 39,077,700 pounds of bluestone, having a copper content of about 9,887,800 pounds, in 1912.

STOCKS.

Returns from all producing companies show that the following stocks of electrolytic, Lake, casting, and pig copper were on hand at the beginning and end of the year 1913:

Stocks of refined copper, in pounds.

Jan. 1, 1913	105,497,683
Jan. 1, 1914	90,385,402
Decrease during 1913	15,112,281

In addition to the stocks of refined copper, there were reported as at the smelters, in transit to the refineries, and at the refineries, blister copper and material in process of refining to the amount of 247,789,811 pounds on January 1, 1914, as compared with 274,072,084 pounds on January 1, 1913.

During 1913 the Copper Producers' Association reported the stock of the marketable copper held at all points in the United States on the first of each month. The following table shows the stocks held on the first of each month:

Stocks of marketable copper of all kinds on hand at all points in the United States on the first day of each month for 1913 and on Jan. 1, 1914, as reported by the Copper Producers' Association.

	Pounds.		Pounds.
January	105,312,582	August	53,594,945
February	123,198,332	September	38,314,037
March	122,302,890	October	29,793,094
April	104,269,270	November	32,566,382
May	75,549,108	December	47,929,429
June	67,474,225		
July	52,814,606	Jan. 1, 1914	91,438,867

IMPORTS AND EXPORTS.

IMPORTS.

The quantity of copper in unmanufactured form imported into the United States in 1913 was 409,560,954 pounds, according to the

records of the Bureau of Foreign and Domestic Commerce. The imports in 1912 were 410,241,295 pounds. The following table shows the character and source of copper-bearing materials imported during 1912 and 1913:

Imports of copper into the United States in 1912 and 1913, by countries, in pounds.

Country.	Ore, matte, and regulus.		Pigs, bars, ingots, plates, old, etc.	
	1912	1913	1912	1913
United Kingdom			1,404,118	17,943,285
Germany	1,217,055	1,067,024		
Spain	5,487,584	6,244,676	31,670,095	35,565,767
Canada	28,930,073	34,072,006	36,138,255	33,749,133
Mexico	18,069,987	19,722,530	124,742,193	97,003,847
Chile	26,749,545	25,311,542	8,627,421	18,315,000
Cuba	10,288,680	5,362,132		
Peru			43,891,439	42,667,436
Japan			19,511,402	14,376,493
Australia and Tasmania			24,700,333	22,149,355
Other countries	14,128,779	17,712,105	14,684,336	17,298,533
Total	104,871,703	109,492,105	305,369,592	300,068,849
Grand total			410,241,295	409,560,954

In 1913 ore to the amount of 472,627 tons, with a copper content of 78,712,101 pounds, and 38,536 tons of matte and regulus, with a copper content of 30,780,004 pounds, were imported. The copper imported as matte and blister included a considerable portion of the 33,300,000 pounds of copper in ore and matte of domestic origin that was treated in foreign plants during the year.

The value of the general imports of copper is reported by the Bureau of Foreign and Domestic Commerce as $57,012,057 in 1912 and $57,901,901 in 1913.

EXPORTS.

The exports of metallic copper from the United States in 1913 amounted to 926,441,142 pounds, according to the Bureau of Foreign and Domestic Commerce. In addition to the exports of metallic copper, the copper content of 65,684 long tons of ore, matte, and regulus was exported in 1913, as compared with the content of 66,171 long tons in 1912.

Exports of domestic copper from the United States in 1912 and 1913, by countries, in pounds.

Country.	Ingots, bars, plates, and old.	
	1912	1913
United Kingdom	95,422,292	133,679,641
Austria-Hungary	38,558,151	34,648,205
Belgium	7,674,273	7,102,120
France	131,362,694	160,000,345
Germany	252,156,012	307,150,761
Italy	47,251,432	41,568,713
Netherlands	152,618,177	178,940,289
Russia in Europe	4,961,473	7,907,672
Other Europe	8,960,973	14,357,014
Canada	30,302,856	36,182,257
Other countries	5,732,325	4,904,125
Total	775,000,658	*a* 926,441,142

a Includes sheets, rods, wire, etc.

The copper exported was in the following forms:

	Pounds.
Pigs, ingots, and bars	818,111,424
Plates and sheets	66,884,021
Rods and wire	37,910,108
All other	3,535,589

The value of the exports of copper is reported by the Bureau of Foreign and Domestic Commerce as $126,211,104 in 1912 and $146,327,700 in 1913.

CONSUMPTION.

The apparent consumption of refined new copper in the United States in 1913 was about 812,068,000 pounds. In 1912 it was about 775,978,000 pounds. The method employed in determining the quantity of copper retained for domestic consumption is shown in the following table, which does not include stocks of copper held by consumers:

Apparent domestic consumption of refined new copper in 1912 and 1913, in pounds.

	1912	1913
Total refinery output of new copper	1,568,104,478	1,615,067,782
Stock at beginning of year	88,372,195	105,497,683
Total available supply	1,656,476,673	1,720,565,465
Refined copper exported	*a* 775,000,658	*a* 818,111,424
Stocks at end of year	105,497,683	90,385,402
Total withdrawn from supply	880,498,341	908,496,826
Apparent consumption	775,978,332	812,068,639

a Exports of pigs, ingots, bars, reported by the Bureau of Foreign and Domestic Commerce.

If to the 812,068,639 pounds of new refined copper is added the 273,000,000 pounds of secondary copper and copper in alloys produced during the year, it is found that a total of about 1,085,000,000 pounds of new and old copper was available for domestic consumption.

The following table shows the monthly deliveries of copper for domestic consumption and export as reported by the Copper Producers' Association:

Monthly deliveries of copper for domestic consumption and for export in 1913 as reported by the Copper Producers' Association, in pounds.

Month.	Domestic consumption.	Export.	Total.
January	65,210,030	60,383,845	126,593,875
February	59,676,492	72,168,523	131,845,015
March	76,585,471	77,699,306	154,284,777
April	78,158,837	85,894,727	164,053,564
May	81,108,321	68,285,978	149,394,299
June	68,362,571	68,067,901	136,430,472
July	58,904,192	78,480,071	137,384,263
August	73,649,801	73,263,469	146,913,270
September	66,836,897	73,085,275	139,922,172
October	68,173,720	68,123,473	136,297,193
November	48,656,858	70,067,803	118,724,661
December	21,938,570	73,542,413	95,480,983
Total	767,261,760	869,062,784	1,636,324,544

USES.

No systematic attempt has been made to ascertain the proportion of the copper output of 1913 used in different industries, as electric transmission, brass manufacture, casting, etc. Some idea of the quantities entering the different industries can be gained from the forms in which the output of the refineries was cast. The following table shows the approximate quantity of copper cast in the different forms during 1913 as reported by the refining companies. It will be noted that the total is not the same as the refinery output for 1913.

Forms in which copper was cast in 1913, in pounds.

Form.	Total.	Per-centage.
Wire bars	938,362,248	58
Ingots and ingot bars	374,700,493	23
Cakes	152,442,677	9
Cathodes	130,429,587	8
Other forms	28,087,047	2
Total	1,624,022,052	100

It may be assumed that a large portion of the 58 per cent cast as wire bars was used for electrical purposes and that the 9 per cent cast as cakes was used largely for rolling. The other forms are less easily classified. The 8 per cent cast as cathodes, together with a portion of the ingots, probably entered the brass industry, and a large quantity of copper ingots was used in casting. The refinery output for 1912 was cast as follows: Wire bars, 54 per cent; ingots, 22 per cent; cakes, 8 per cent; cathodes, 14 per cent; other forms, 2 per cent.

Aron Hirsch & Sons in their "Copper statistics for 1913" give the distribution as shown in the following table for the copper consumed in the United States in 1913:

Consumption of copper in the United States by industries, as estimated by Aron Hirsch & Sons, in pounds.

Industry.	Quantity.	Percentage.
Electrical industry (including copper wire)	400,000,000	52.
Brass mills	220,000,000	28.
Copper sheets	105,000,000	13.
Miscellaneous (chiefly casting and alloys)	42,000,000	5.
Total	767,000,000	100.0

PRICES.

The average yearly quoted price of electrolytic copper at New York in 1913 was about 15.52 cents a pound; in 1912 the price was 16.48 cents a pound. The average monthly prices for electrolytic copper in 1911, 1912, and 1913, as reported in "Metal statistics," American Metal Market Co., are given in the following table:

Average monthly prices at New York per pound of copper in 1911, 1912, and 1913, in cents

Month.	Price of electrolytic copper, in cents.		
	1911	1912	1913
January	12.53	14.27	16.75
February	12.48	14.26	15.27
March	12.31	14.78	14.92
April	12.155	15.85	15.48
May	12.13	16.16	15.63
June	12.55	17.29	14.85
July	12.625	17.35	14.57
August	12.575	17.60	15.68
September	12.39	17.67	16.55
October	12.36	17.60	16.54
November	12.77	17.49	15.47
December	13.71	17.505	14.47
Average	12.55	16.48	15.52

The average yearly price of Lake copper was 15.70 cents. New York quotations are used by the United States Geological Survey in calculating the value of both mine and smelter output. It is well known, however, that this average yearly price only approximates the actual average price received for copper sold during the year.

The average selling price received by several large producers of electrolytic copper, as given in their annual reports, varies from 14.879 cents to 15.748 cents, with an average of 15.31 cents, which indicates that the average as indicated by the quotations was considerably above the actual average price realized by producers.

In the case of Lake mines the average price received by companies reporting was 15.44 cents per pound.

WORLD'S PRODUCTION.

The smelter production of copper in the world was 2,198,732,130 pounds in 1913, as compared with 2,259,101,580 pounds in 1912. In 1913 the smelter output of the United States was 55.6 per cent of the world's production, as compared with 55 per cent in 1912.

The following table shows the world's production by countries. The figures are those compiled by Henry R. Merton & Co. (Ltd.), reduced to pounds, except that the official figures for the production of the United States and Canada are inserted.

World's production (smelter output) of copper in 1912 and 1913, in pounds.

[Copper extracted from ore or contained in the ore produced.]

Country.	1912	1913
Germany	56,437,760	55,776,380
England	661,380	661,380
Italy	5,070,580	3,527,360
Norway	24,471,060	19,400,480
Austria	8,597,940	8,377,480
Russia	73,854,100	74,735,940
Sweden	3,306,900	2,204,600
Spain and Portugal	132,055,540	120,591,620
Turkey	1,102,300	1,102,300
Hungary	220,460	661,380
Servia	16,314,040	14,109,440
Total Europe	322,092,060	301,148,360
Canada	77,775,600	76,975,832
Mexico	162,479,020	116,402,880
Newfoundland	1,102,300	.....
United States	1,243,268,720	1,224,484,098
Total North America	1,484,625,640	1,417,862,810
Argentina	661,380	220,460
Bolivia	8,157,020	8,157,020
Chile	83,554,340	88,184,000
Peru	58,421,900	56,658,220
Venezuela	3,086,400	2,865,980
Cuba	9,700,240	7,495,640
Total Central America and South America	163,581,280	163,581,320
Cape Colony	8,597,940	7,275,180
Namaqualand	5,511,500	5,511,500
Other Africa	22,486,920	37,698,660
Total Africa	36,596,360	50,485,340
Japan	146,826,360	161,376,720
Australia	105,379,880	104,277,580
Grand total	2,259,101,580	2,198,732,130

GOLD, SILVER, COPPER, LEAD, AND ZINC IN MONTANA.

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

GENERAL STATEMENT.

Ore, concentrates, and bullion produced in Montana during the calendar year 1913 yielded gold, silver, copper, lead, and zinc, valued at $61,900,546. This was the value of the output made by 558 producers; in 1912 there were 604 productive mines, with an output valued at $64,754,613. The decrease of $2,854,067 in total value as compared with 1912 was mainly due to the reduced output of gold and copper. The value of silver, lead, and zinc combined was $3,771,202 greater than in 1912, while the value of the gold and copper was $6,625,269 less. Silver Bow County, which includes the Butte or Summit Valley district, produced 28.4 per cent of the gold, 88.4 per cent of the silver, 99.2 per cent of the copper, 41.5 per cent of the lead, 99.8 per cent of the zinc, and over 93 per cent of the total value of the product from deep mines.

A comparison of totals for metals produced from 1904 to 1913, inclusive, is as follows:

Tons of ore sold or treated in Montana, 1904–1913, number of producers, and mine production of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total. value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904.....	210	4,643,092	$4,267,062	12,817,285	290,681,572	2,299,291	.....	$48,974,381
1905.....	332	5,020,137	4,794,083	13,231,300	304,723,526	6,264,998	1,560,000	60,709,155
1906.....	370	5,497,971	4,469,014	11,980,705	290,700,975	4,462,979	6,579,000	69,257,083
1907.....	436	4,148,496	3,286,212	9,317,605	220,108,792	3,748,304	243,100	53,670,592
1908.....	566	4,266,022	3,057,640	10,356,199	251,667,795	4,596,570	1,640,000	42,036,710
1909.....	619	5,421,185	3,791,510	12,378,714	312,058,011	2,983,430	9,359,724	51,429,694
1910.....	578	5,079,446	3,730,486	12,162,857	284,808,553	4,106,292	31,638,184	48,358,253
1911.....	610	4,940,303	3,710,571	11,985,196	272,847,705	6,431,575	43,810,145	46,955,287
1912.....	604	5,552,164	3,625,235	12,731,638	309,738,873	7,446,749	26,918,881	64,754,613
1913.....	558	5,960,118	3,493,432	13,819,201	287,828,699	10,935,827	88,673,083	61,900,546
Increase (+) or decrease (−) in 1913.....		+407,954	−131,803	+1,087,563	−21,910,174	+3,489,078	+61,754,202	−2,854,067

[a] Includes placer production.

ORE PRODUCTION IN 1913.

The total quantity of ore sold or treated was 5,960,118 tons, against 5,552,164 tons in 1912, showing an increase of 407,954 tons, but the total average recoverable value per ton of ore decreased from $11.52 in 1912 to $10.25 in 1913, and the value of the gold and silver contained in this ore from $1.92 to $1.85 per ton. Mines in Silver Bow County are credited with the largest output of ore, aggregating 5,612,530 tons. Of the tonnage produced in Silver Bow County, 5,287,215 tons, or 94.2 per cent, was copper ore; 296,940 tons lead-zinc ore; 24,223 tons dry or siliceous ore; 3,763 tons zinc ore; and 389 tons lead ore. The dry or siliceous ores aggregated 284,488 tons, of which 229,520 tons were classified as gold ore, 13,586 tons as gold and silver ore, and 41,382 tons as silver ore. The largest part, or 158,932 tons, of the dry or siliceous ore was treated by cyanidation; 14,508 tons were treated by amalgamation; and 103,185 tons were shipped directly to the smelters for treatment. Although Blaine and Fergus counties have reduced tonnages of siliceous ores, 80,664 and 55,195 tons, respectively, they remained the largest producers. Oxidized iron ores, aggregating 33,266 tons, some of them containing upward of 20 per cent excess iron and a little gold, were mined in the Georgetown district of Deer Lodge County, and a similar ore, of lower grade, near Elkhorn, in Jefferson County. Iron sulphides containing nearly an ounce of gold and a little silver and copper continued to be mined in Broadwater County, near Radersburg. The copper ores aggregated 5,335,851 tons, of which 4,610,402 tons were of milling grade, and produced 1,421,566 tons of concentrate averaging 35 cents in gold, 5.14 ounces of silver, 7.21 per cent of copper, and in gross value $25.81 per ton. The copper ore of shipping grade amounted to 692,701 tons, largely sulphides, containing 23 cents in gold, 4.34 ounces of silver, 5.22 per cent of copper, and in gross value $19.03 per ton. Of the 27,270 tons of lead ore, over half, or 14,697 tons, was shipped directly to the smelters and contained $2.73 in gold, 26.25 ounces of silver, 0.3 per cent of copper, 11.65 per cent of lead, and an average gross value of $29.75 per ton. The remainder of the lead ore, 12,573 tons, was concentrated and produced 3,388 tons of concentrates containing an average of $1.84 in gold and 31.93 ounces of silver per ton, and 0.17 per cent of copper and 33.5 per cent of lead. Lead concentrates were also separated from zinc-lead ore, of which 307.615 tons were treated, and yielded 2,683 tons of lead concentrate averaging $1.51 in gold, 45.75 ounces of silver, 0.30 per cent of copper, and 39.49 per cent of lead. The average gross value per ton of the two lead concenrates combined was $57.23. Zinc concentrates recovered from the zinc-lead ore aggregated 105,524 tons, averaging 60 cents in gold and 14.52 ounces of silver per ton, and 0.28 per cent of copper, 1.26 per cent of lead, and 41.98 per cent of zinc (spelter), the total gross value being $58.34 per ton. The average metallic content and values per ton of the concentrates and crude ores smelted appear in the sections following.

The total output of each kind of ore mined was as follows:

Output of ore and production of metals in Montana in 1913, by kinds of ore.

Source of production.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	128	.....	38,748.47	5,623	.....	.....	.....
Dry or siliceous ore	284	284,488	92,749.19	1,335,602	676,184	180,678	.....
Copper ore	70	5,335,851	32,084.86	10,311,807	286,393,731	20,456	.....
Lead ore	84	27,270	2,114.18	493,326	97,826	5,680,139	.....
Zinc ore	3	3,840	6.00	18,043	.....	.....	751,185
Copper-lead ore	2	1,054	32.85	14,557	64,083	283,323	.....
Lead-zinc ore	4	307,615	3,259.22	1,640,243	596,875	4,771,231	87,921,898
Total	.....	5,960,118	168,994.77	13,819,201	287,828,699	10,935,827	88,673,083

Subdivision of tonnage of ore sold or treated in Montana, in 1913, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaverhead	244	82	4,079	.....	.....	.....	4,405
Blaine	80,664	.....	.....	.....	.....	.....	80,664
Broadwater	17,805	80	247	.....	.....	.....	18,132
Cascade	43	5	13,404	.....	.....	148	13,600
Deer Lodge	33,266	.....	.....	.....	.....	.....	33,266
Fergus	55,195	.....	38	77	.....	.....	55,310
Granite	25,484	12,409	95	.....	.....	.....	37,988
Jefferson	4,643	33,421	5,919	.....	.....	166	44,149
Lewis and Clark	24,587	74	716	.....	.....	.....	25,377
Lincoln	90	.....	35	.....	.....	.....	125
Madison	15,120	120	2,008	.....	.....	.....	17,248
Meagher	.....	5	.....	.....	.....	.....	5
Missoula	2,804	452	219	.....	.....	10,361	13,836
Powell	286	1,846	45	.....	.....	.....	2,177
Ravalli	12	42	.....	.....	12	.....	66
Sanders	22	100	76	.....	1,042	.....	1,240
Silver Bow	24,223	5,287,215	389	3,703	.....	296,940	5,612,530
Total	[a] 284,488	5,335,851	27,270	3,840	1,054	307,615	5,960,118
Value per ton in gold and silver	$9.53	$1.29	$12.53	$2.87	$8.98	$3.44	$1.85

[a] Includes 229,520 tons of gold ore, 13,586 tons of gold and silver ore, and 41,382 tons of silver ore.

GOLD.

Montana's production of gold decreased from 175,370.74 fine ounces, valued at $3,625,235, in 1912 to 168,994.77 fine ounces, valued at $3,493,432 in 1913, or a decrease of 6,375.97 ounces in quantity and of $131,803 in value. Madison County is credited with the largest output, amounting to $870,397, from deep and placer mines, the output of the latter amounting to $691,651, against $689,197 in 1912. Deep or lode mines in Silver Bow County continued to produce the largest part of the total gold, or $774,533 in 1913, against $793,236 in 1912. At amalgamation and cyanidation plants $806,781 in gold was produced, with an average recovery of $4.45 per ton of ore and tailings treated. Ore treated at concentration mills produced concentrates containing $615,909 in gold, averaging 0.402 cents per ton. The crude ore shipped to smelters contained $1,269,740 in gold, or an average of $1.56 per ton.

Source of gold production in Montana, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Beaverhead	132.02	1,132.26	1.50	27.82	.....	.....	.....	1,293.60
Blaine	.....	13,762.54	.....	.....	.....	.....	.....	13,762.54
Broadwater	171.97	17,392.90	9.09	108.17	.....	.....	.....	17,682.13
Cascade	3.63	13.88	.....	242.31	.....	.....	3.00	262.82
Deer Lodge	.....	13,209.57	.....	.....	.....	.....	.....	13,209.57
Fergus	.....	22,238.09	.....	.53	.....	.....	.....	22,238.62
Granite	936.39	4,842.43	86.36	2.56	.....	.....	.....	5,867.74
Jefferson	102.12	1,577.02	465.32	932.08	.....	.....	26.04	3,102.58
Lewis and Clark	1,145.13	6,092.83	77.61	104.62	.....	.....	.....	7,420.19
Lincoln	4.89	99.60	.....	13.88	.....	.....	.....	118.37
Madison	33,458.62	8,269.95	23.75	353.13	.....	.....	.....	42,105.45
Meagher	37.44	.....	.....	.....	.....	.....	.....	37.44
Missoula	702.74	401.97	17.35	.....	.....	.....	1.98	1,124.04
Park	123.55	.....	.....	.....	.....	.....	.....	123.55
Powell	1,148.04	356.76	675.81	86.44	.....	.....	.....	2,267.05
Ravalli	502.28	9.81	.....	.....	.....	8.76	.....	520.85
Sanders	27.57	43.64	41.80	1.01	.....	24.09	.....	138.11
Silver Bow	252.08	3,305.94	30,686.27	241.63	6.00	.....	3,228.20	37,720.12
Total	38,748.47	[a]92,749.19	32,084.86	2,114.18	6.00	32.85	3,259.22	168,994.77

[a] Includes 84,748.32 ounces from gold ore, 3,763.07 ounces from gold and silver ore, and 4,237.81 ounces from silver ore.

SILVER.

The production of silver in 1913 was 13,819,201 ounces, valued at $8,346,797, breaking records for the last 10 years, and was 1,087,563 ounces greater than the output of 1912. About three-fourths of the silver, or 10,311,807 ounces, was contained in the copper ores, which averaged 1.93 ounces per ton. Silver Bow, Granite, and Cascade counties made the largest increases in silver. Dry or siliceous ores yielded 1,335,602 ounces, or nearly 10 per cent of the total. Cyanidation and amalgamation mills produced precipitates and bullion containing 86,262 ounces, concentration mills produced concentrates containing 9,100,418 ounces of silver, and crude ore shipped to smelters contained 4,626,898 ounces.

Source of silver production in Montana, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Beaverhead	11	4,323	1,087	42,068	.....	.....	.....	47,489
Blaine	.....	24,997	.....	.....	.....	.....	.....	24,997
Broadwater	24	8,261	207	3,609	.....	.....	.....	12,101
Cascade	2	3,690	12	287,551	.....	.....	1,011	292,266
Deer Lodge	.....	13,911	.....	.....	.....	.....	.....	13,911
Fergus	.....	9,688	.....	251	.....	.....	.....	9,939
Granite	270	720,581	2,899	6,027	.....	.....	.....	729,777
Jefferson	18	15,614	99,958	110,128	.....	.....	2,046	227,764
Lewis and Clark	191	37,549	2,975	10,729	.....	.....	.....	51,444
Lincoln	.....	12	.....	402	.....	.....	.....	414
Madison	4,880	69,045	56	8,472	.....	.....	.....	82,453
Meagher	6	.....	.....	.....	.....	.....	.....	6
Missoula	33	48	2,627	11,229	.....	.....	22,957	36,894
Park	16	.....	.....	.....	.....	.....	.....	16
Powell	111	6,260	52,525	1,738	.....	.....	.....	60,634
Ravalli	31	3	164	.....	.....	161	.....	359
Sanders	3	29	1,272	1,312	.....	14,396	.....	17,012
Silver Bow	27	421,591	10,148,025	9,810	18,043	.....	1,614,229	12,211,725
Total	5,623	[a]1,335,602	10,311,807	493,326	18,043	14,557	1,640,243	13,819,201

[a] Includes 101,350 ounces from gold ore, 245,324 ounces from gold and silver ore, and 988,928 ounces from silver ore.

COPPER.

Copper recovered from Montana ores decreased from 309,738,873 pounds, valued at $51,106,914, in 1912, to 287,828,699 pounds, valued at $44,613,448, in 1913, a decrease of 21,910,174 pounds in quantity and of $6,493,466 in value. Silver Bow County, or practically the Butte district, contributed all the copper with the exception of 2,147,141 pounds. Jefferson County mines yielded the next largest quantity, or 874,164 pounds, followed by Broadwater and Granite counties. Crude ore smelted in 1913 contained 73,129,317 pounds, or an average of 4.50 per cent. The sulphide copper ore of smelting grade predominated and contained 70,552,961 pounds of copper, or an average of 5.25 per cent of copper, and the oxidized copper ores contained 1,733,043 pounds, or 4.01 per cent of copper. Copper precipitates produced from mine waters and the washings from old tailings contained 8,365,202 pounds, against 6,333,918 pounds of copper in 1912. Concentrates shipped to smelters contained 205,661,412 pounds of copper, the bulk of which was from copper concentrates which averaged 7.21 per cent of copper. The output of copper from the Summit Valley or Butte district decreased from 308,222,547 pounds in 1912 to 285,649,058 pounds in 1913. According to the statement of a principal producer, this decrease was due largely to the extensive repairs which one of the companies found it necessary to make; to the fact that on account of conditions the railroads at times were unable to deliver a sufficient quantity of ore to the several reduction works; and also to the fact that the grade of ore treated was somewhat lower than that of 1912. The new companies have not, so far, advanced sufficiently in their operations to make a production appreciable in the total output from the district.

Three experimental plants for leaching low-grade copper ores were in operation, one in Granite County and two at Butte. The output of copper from the experiments aggregated 172,768 pounds.

Source of copper production in Montana, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaverhead	1,346	22,390	41,945	.....	.....	65,681
Broadwater	387,894	10,675	222	.....	.....	398,791
Cascade	.....	365	2,988	.....	364	3,717
Deer Lodge	94,844	.....	.....	.....	.....	94,844
Fergus	41	.....	1,032	.....	.....	1,073
Granite	32,621	329,745	.....	.....	.....	362,366
Jefferson	58,810	773,772	38,677	.....	2,905	874,164
Lewis and Clark	2,423	8,911	842	.....	.....	12,176
Madison	20,291	4,630	1,062	.....	.....	25,983
Meagher	.....	1,333	.....	.....	.....	1,333
Missoula	.....	90,329	.....	.....	.....	90,329
Powell	2,215	124,302	365	.....	.....	126,882
Ravalli	.....	4,099	.....	971	.....	5,070
Sanders	.....	19,057	2,563	63,112	.....	84,732
Silver Bow	75,699	285,004,123	8,130	.....	593,606	285,681,558
Total	[a] 676,184	286,393,731	97,826	64,083	596,875	287,828,699

[a] Includes 570,649 pounds from gold ore, 35,101 pounds from gold and silver ore, and 70,434 pounds from silver ore.

LEAD.

The output of lead aggregated 10,935,827 pounds, valued at $481,176, against 7,446,749 pounds, valued at $335,104, in 1912. Of the 1913 output, 41.5 per cent was derived from mines in Silver Bow County, which produced 4,542,225 pounds, against 1,296,283 pounds in 1912. This increase was due largely to the output of lead in zinc-lead ores, which were concentrated. The next largest output of lead, or 3,179,501 pounds, came from Cascade County mines, followed by Jefferson County, with 1,519,768 pounds. Crude ore shipped to the smelters contained about one-third of the total lead, or 3,894,254 pounds, and the remainder, 7,041,573 pounds, was contained in concentrates. The lead ore of shipping grade contained 3,423,048 pounds of lead, or an average of 11.65 per cent, and the copper-lead ore contained 283,323 pounds, or an average of 13.44 per cent of lead.

Source of lead production in Montana, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaverhead	.....	.....	284,175	.....	.....	284,175
Broadwater	1,177	.....	54,104	.....	.....	55,281
Cascade	2,466	.....	3,167,347	.....	9,688	3,179,501
Fergus	.....	.....	17,457	.....	.....	17,457
Granite	53,159	.....	17,673	.....	.....	70,832
Jefferson	12,881	.....	1,478,199	.....	28,688	1,519,768
Lewis and Clark	102,918	61	120,214	.....	.....	223,193
Lincoln	.....	.....	21,747	.....	.....	21,747
Madison	7,623	.....	254,867	.....	.....	262,490
Missoula	.....	.....	107,764	.....	307,309	415,073
Powell	342	19,199	10,471	.....	.....	30,012
Ravalli	.....	.....	.....	3,301	.....	3,301
Sanders	112	.....	30,638	280,022	.....	310,772
Silver Bow	.....	1,196	115,483	.....	4,425,546	4,542,225
Total	[a] 180,678	20,456	5,680,139	283,323	4,771,231	10,935,827

[a] Includes 118,095 pounds from gold ore, 27 pounds from gold and silver ore, and 62,556 pounds from silver ore.

ZINC.

The output of zinc (figured as spelter) in Montana was 88,673,083 pounds, valued at $4,965,693, in 1913, as against a yield of 26,918,881 pounds, valued at $1,857,403, in 1912. The bulk of the zinc output was from Silver Bow County and lesser quantities were from Missoula, Fergus, Jefferson, and Cascade counties. From the Butte-Superior mine at Butte was produced the largest quantity of zinc concentrates, aggregating 102,102,868 gross pounds, with an average zinc content of 49 per cent. During the last part of 1913, the zinc concentrate of this company averaged gross 50.54 per cent. With immense bodies of high-grade zinc ore being developed and concentrated, the Butte district promises to be one of the greatest zinc centers.

Source of zinc production in Montana, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Cascade	.....	4,510	4,510
Fergus	49,999	.....	49,999
Jefferson	.....	10,501	10,501
Missoula	.....	78,999	78,999
Silver Bow	701,186	87,827,888	88,529,074
Total	751,185	87,921,898	88,673,083

MINING INDUSTRY IN MONTANA IN 1913.

Mining, milling, and smelting methods in Montana have never been in better condition than they were in 1913. In the Butte district especially, the substitution of electric and compressed-air power for steam power in hoisting systems and in the operation of the railroad that serves the mines and smelters is reported to have lowered cost of production considerably. The use of electric power has become general throughout the Butte district, the power being furnished by the Montana Power Co. and generated at several points on Missouri, Madison, and Bighole rivers. Some new mining work was begun in the extreme western end of the Butte district, in a section known as the Burlington district, where the ores were worked many years ago for silver. In other mining districts, new electrical and milling equipment has been reported, accounts of which will be found in the review by counties and districts. The electrification of the Butte, Anaconda & Pacific Railway[1] from the mines at Butte to the reduction works at Anaconda was completed in 1913. It is reported that the resulting economies are exceeding expectations and that the operations in general are much more satisfactory than when the road was operated by steam. This piece of work is said to be the pioneer movement in electrification in the Rocky Mountain region. It has been reported that the Chicago, Milwaukee & St. Paul Railway will change to electricity the 450 miles of main line from Harlowtown, Mont., to Avery, Idaho, and that the work will be completed in three years. After this has been done the work of electrification will probably be carried on to the Pacific coast. During the summer of 1913 engineers and surveyors began operations laying out the route of the Butte, Wisdom & Pacific Railway, the subsidiary of the Boston & Montana Development Co. which will build a 100-mile road through the Bighole Basin and connect the two mining towns of French Gulch (in Deer Lodge County) and Elkhorn[2] (in Beaverhead County).

METALLURGICAL INDUSTRY.

Sixty milling plants of various kinds were in operation in Montana during 1913. Most of these were operated for short periods. Thirteen plants, including 2 arrastres, used the amalgamation method; 6, amalgamation and concentration; 3, amalgamation and cyanidation; 18 were straight cyanide mills; 13 were straight concentration mills; 2 used concentration and cyanidation; and 1 used amalgamation, concentration, and cyanidation; 3 were copper leaching plants; and 1 was a copper precipitating plant, which extracted copper from mine waters. Of the 173,440 tons of ore treated at gold and silver mills, 14,508 tons were treated by amalgamation and yielded 2,344.18 ounces of gold and 1,407 ounces of silver, or an average recovery of $3.34 in gold and 0.10 ounce of silver per ton. The ore treated by cyanidation aggregated 158,932 tons, which with 7,816 tons of old tailings, yielded 36,683.87 ounces of gold and 84,855 ounces of silver, or an average recovery for ore and tailings of $4.54 in gold and 0.51 ounce of silver per ton. The total value of the bullion recovered from ore and tailings was $858,883, as against the output in 1912 amounting to $1,081,563.

[1] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1913.
[2] Min. and Sci. Press, August 16, 1913, p. 275.

Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver recovered in bullion produced in Montana in 1913, by counties.

County.	Quantity.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Blaine	80,606	.....	.....	13,012.54	23,537	$283,209
Broadwater	[a]7	186.66	43	.....	.....	3,885
Deer Lodge	25	31.00	3	.....	.....	643
Fergus	54,493	.....	.....	19,031.04	4,456	396,097
Granite	253	92.63	5	[b]96.91	136	4,003
Jefferson	36	48.17	14	.....	.....	1,005
Lewis and Clark	[c]17,707	1,009.07	1,098	[d]3,528.58	12,861	102,232
Lincoln	90	99.61	12	.....	.....	2,066
Madison	[e]12,582	662.24	213	628.61	26,592	42,874
Missoula	204	60.00	5	[f]341.98	43	8,339
Powell	19	17.49	2	.....	.....	363
Ravalli	12	9.83	3	.....	.....	205
Sanders	9	7.72	4	.....	.....	163
Silver Bow	[g]7,397	119.76	5	44.21	17,230	13,799
Total	173,440	2,344.18	1,407	36,683.87	84,855	858,883

[a] Also yielded 1 ton of concentrate.
[b] Includes bullion from 196 tons of old tailings.
[c] Also yielded 49 tons of concentrate.
[d] Includes bullion from 5,020 tons of old tailings.
[e] Also yielded 642 tons of concentrate.
[f] Produced from 2,600 tons of old tailings.
[g] Also yielded 224 tons of concentrate.

A great deal of attention was given to experimental work with new processes by several of the large companies operating in Montana, apparently with promising results. The processes, if worked out satisfactorily, will mean much to Butte and to other districts in the future. At the Washoe works of the Anaconda Copper Mining Co.[1]—

the final tests on the concentration of slime material by centrifugal machines, mention of which was made in previous reports, were completed during the year, and while the results were fairly good, it was decided not to adopt this method, but to use the round table in preference, as the cost of operating and maintenance of the latter was found to be much less than that of the centrifugal device, and the results obtained were about equal. A modification of the round table as used in general practice was tested out at the Washoe plant, and found to work very satisfactorily. The table as devised by the engineers at the Washoe Smelter has 20 decks upon one shaft instead of the limited number formerly used. It was decided to erect a round table plant capable of handling 2,000 tons of slime material per day. Excavation work was started late in September, 1913. Erection of the steel was started late in November, and it is expected the plant will be ready for operation some time during the first half of the year 1914. The plant consists of three buildings, viz:

The slimes dewatering plant, containing 160 Dorr thickening tanks;
The round table plant, containing 20 round tables of 20 decks each, and
The concentrate dewatering plant, containing 5 Dorr thickening tanks.

It is expected that this operation will produce about 300 tons of concentrates per day, which will yield about 1,000,000 pounds of copper per month at a very low cost per pound of copper produced. The leaching tests on sand tailings, which were made during the year 1912 with a 5-ton experimental plant, promised so well that it was decided to erect an 80-ton plant in order to demonstrate the efficiency of a larger working unit. This plant was completed on August 15 and operated throughout the rest of the year, and the results were so good that plans are now being made for the erection of a unit of 2,000 tons capacity. This unit when completed will handle about one-third of the sand tailings coming from the concentrator. * * * Good progress was made in building the new smelter at Great Falls, and on December 31, 1913, about 50 per cent of the work was completed. It is not the intention to do any remodeling

[1] Ann. Rept. for year ending Dec. 31, 1913.

or rebuilding at the concentration department, but eventually to shut down the present plant, sending the concentrating ores formerly treated at this department to the concentrator at the Washoe smelter, and shipping the resulting concentrates to Great Falls for treatment.

Within the last two years plans have been made to mine and treat the low-grade oxidized ores, of which a vast body lies along the base of the low hills near the Pittsmont smelter. The ore consists of the usual Butte granite, stained or enriched by copper minerals, chiefly chrysocolla and malachite. It carries from 1 to 4 per cent of copper and is of such character as to yield readily to wet treatment process. Two leaching plants were in operation during 1913, having a combined capacity of 300 tons. These are designed as experimental plants and are soon to be enlarged. The crushed ore is treated with weak sulphuric acid, readily dissolving the copper. From the resulting solution, the copper is deposited electrolytically in the form of cathodes, measuring 24 inches by 34 inches, weighing about 65 pounds each, which are pure and ready for the market. Another copper leaching plant similar to those at Butte operated during 1913 on the ores from the North Star mine at Maxville, in the Flint Creek district of Granite County.

The reduction plant of 1,000 tons daily capacity, erected near Helena, Mont., by the Northwestern Metals Co., is nearly ready to start. The process is one of leaching and is devised to treat complex sulphide ores. The bases of the ores are all chloridized with chlorine gas and are then precipitated in groups. The iron and manganese are precipitated first by zinc carbonate and sodium hyperchlorite. Then the lead, copper, silver, and gold are precipitated by zinc shaving. Finally the zinc is precipitated by sodium carbonate. The chemicals are practically all made at the plant.

The East Helena smelter,[1] controlled by the American Smelting & Refining Co. since 1899, has added improvements from time to time.

The plant is 4 miles east of Helena on the Northern Pacific and the Great Northern railroads, with hourly street-car service from Helena. Electric power is obtained from Canyon Ferry dam, 12 miles east, on Missouri River, and about 800 horsepower is used in the blowing engines, crushing machinery, cranes, and locomotives. Besides the Montana ores convenient to the above-named railroads, a large part of the ore supply comes from the Coeur d'Alene district, Idaho, and is mainly lead ore and concentrates. A modern automatic sampling mill with Vezin samplers and a capacity of 50 tons per hour was completed in 1912. Three blast furnaces, each 48 inches by 136 inches, are now in continuous operation and the monthly production of silver-lead bullion is 6,000 tons. A part of the ore roasting is done in Godfrey furnaces in connection with the Huntington-Heberlein process, 12 pots being in use with a capacity of 300 tons per day. Four Dwight-Lloyd sintering furnaces, each 42 inches by 264 inches, and a small experimental machine with a combined capacity of 440 tons per day are in steady operation. These machines are in great favor and results are being carefully watched. Three bag houses are used in connection with the 1,800-foot brick flue chamber, and each bag house contains 1,260 cotton bags each 18 inches in diameter by 30 feet long, suspended on vertical rods. The product saved by the bags contains about 50 per cent lead and is re-treated in the blast furnace after sintering. About 450 men are employed.

Adjacent to the abandoned smelting works of the Colusa-Parrot Mining & Smelting Co.[2] at Butte, which was one of the W. A. Clark properties purchased by the Anaconda Co. in 1910, is a large accumulation (estimated at close to a million tons) of tailings from the concentrator, which contain a gross value in silver and copper of

[1] Described in pamphlet issued by committee Am. Inst. Min. Eng. Butte meeting, August, 1913.
[2] Gore, Bancroft: Treatment of Tailing at Butte Reduction Works; Min. and Sci. Press, Mar. 28, 1914, p. 529.

more than $3,000,000. This valuable dump was retained by the Clark interests pending a thorough investigation by a large staff of testing engineers, making use on a large working scale of the latest developments in hydrometallurgy and ore dressing. One section of the old concentrator not destroyed by fire was remodeled and fitted with every known device that might throw light upon the commercial treatment of this tailing. Preference was finally given to the oil flotation process rather than roasting and leaching, as is done at Anaconda with similar material. Elaborate mill tests were made under supervision of the Minerals Separation American Syndicate (Ltd.), a 50-ton agitation unit being used where a high recovery of the sulphides was demonstrated. One factor in favor of the process was the extreme simplicity of the operations. The raw tailing was fed directly to a Hardinge tube-mill and, after crushing to pass 60-mesh screen, it entered the flotation unit where a remarkably clean, high-grade product was removed, dried, sampled, assayed, weighed, and shipped for treatment to the Anaconda smelter. As the tailing has been exposed to weathering, a part of the copper occurs as oxides, sulphates, and basic sulphates, which will be recovered by a preliminary treatment with weak sulphuric acid solutions. The tube mills are to be lead-lined on this account. A plant with initial daily capacity of 1,000 tons has been designed and will be in operation before 1915.

The milling of zinc ores at Butte has proved a success. One concentration mill is operated by the Butte-Superior Co. on zinc ores, and another mill is under construction at Timber Butte, for the treatment of the zinc ores from the Elm Orlu mine. It is planned to have this mine in operation early in 1914. Most of the zinc ores thus far found in the Butte district are mixed with considerable pyrite, but those found in the Black Rock and Elm Orlu mines contain very little pyrite, so that a concentrate low in iron is possible. The Butte-Superior [1] concentrator is rated at 1,200 tons daily capacity. The ore is sphalerite, most of which is finely disseminated through a hard quartz gangue, with small quantities of galena, pyrite, chalcopyrite, rhodochrosite, and rhodonite. In mining the included granite and low-grade vein matter are sorted out and used for waste filling so that the ore, as it goes to the concentrator, will carry about 20 per cent zinc, 1 per cent of lead, 0.25 per cent of copper, 8 to 10 ounces of silver, and a little gold. The ore is hard and tough, requiring extensive crushing and grinding equipment, consisting of Blake and gyratory crushers, 54-inch and 42-inch high-speed rolls, Chile mills, tube and conical mills. All of the lead concentrate and part of the zinc concentrate are recovered in the upper part of the mill by jigs and tables. The classifier overflow and the reground jig and table tailings go to settling tanks, and from there to the Hyde flotation process, where the remainder of the zinc concentrate is recovered and the tailings go to waste.

The following tables give the quantity of material shipped from the concentration mills and of crude ore to the smelters, with metal yield by counties in 1913; also the kind of concentrate and the metals contained in each kind, showing the average content covering the period from 1903 to 1913, inclusive:

[1] General descriptive booklet of Mining in Montana issued for Butte meeting American Institute of Mining Engineers, Butte, Mont., August, 1913.

Mine production of gold, silver, copper, lead, and zinc, from Montana concentrates in 1913, by counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaverhead	3,682	190	11.11	14,290	10,229	97,336	.....	$14,730
Broadwater	159	54	35.63	1,776	209	27,095	.....	3,034
Cascade	7,380	2,962	102.76	89,888	364	2,017,390	4,510	145,490
Jefferson	30,512	4,891	102.18	40,942	542,254	28,688	10,501	112,740
Lewis and Clark	.....	49	71.33	450	30	9,250	.....	2,158
Madison	1,642	826	1,832.06	19,448	4,745	128,959	.....	56,029
Missoula	10,361	440	2.00	22,957	.....	307,309	78,999	31,853
Silver Bow	4,876,896	1,524,594	27,637.54	8,910,667	205,103,581	4,425,546	88,501,832	12,895,243
Total	4,930,632	1,534,006	29,794.61	9,100,418	205,661,412	7,041,573	88,595,842	13,261,277
Subdivision by kinds of concentrates:								
Dry or siliceous		845	1,819.24	29,921	2,750	.....	.....	56,105
Copper		1,421,566	24,411.61	7,307,696	205,049,757	.....	.....	36,701,194
Lead		6,071	502.92	230,939	28,304	4,389,887	.....	327,426
Zinc		105,524	3,060.84	1,531,862	580,601	2,651,686	88,595,842	6,156,552

Kinds of concentrates and average metallic content of each kind produced in Montana in 1911–1913.

Kind and source of concentrates.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead	Zinc (spelter).	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine ozs. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Gold and silver mills—							
1911	1,436	$68.29	24.10	0.38	.....	.....	$82.02
1912	1,000	92.62	14.81	.33	0.53	.....	103.30
1913	831	44.75	35.46	.14	.....	.....	66.61
Concentration mills—							
1912	663	3.93	91.66	.26	7.99	.....	68.34
1913	14	29.93	32.21	1.37	.....	.....	53.64
Copper:							
Concentration mills—							
1911	1,255,572	.38	5.62	7.69	.....	.....	22.58
1912	1,496,476	.36	5.37	7.30	.....	.....	27.75
1913	1,421,566	.35	5.14	7.21	.....	.....	25.82
Lead:							
Concentration mills—							
1911	2,485	4.01	66.48	.18	25.88	.....	62.99
1912	3,436	3.99	24.83	.08	39.62	.....	54.66
1913	5,985	1.27	38.47	.23	36.56	.....	57.39
Gold and silver mills—							
1911	21	34.81	7.57	.75	10.35	.....	50.00
1913	86	32.41	7.82	.51	7.70	.....	45.47
Zinc:							
Concentration mills—							
1911	61,165	.28	8.03	1.09	.69	35.75	48.65
1912	32,947	.69	12.22	.35	1.87	40.66	67.16
1913	105,524	.60	14.52	.28	1.26	41.98	58.34

Mine production of gold, silver, copper, lead, and zinc, from Montana crude ore shipped to smelters in 1913, by counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaverhead	723	1,150.47	33,188	55,452	186,839	.....	$60,643
Blaine	58	750.00	1,460	.....	.....	.....	16,386
Broadwater	17,966	17,287.87	10,258	398,582	28,186	.....	426,588
Cascade	6,220	156.43	202,376	3,353	1,162,111	.....	177,121
Deer Lodge	33,241	13,178.57	13,908	94,844	.....	.....	295,526
Fergus	817	3,207.58	5,483	1,073	17,457	49,999	73,353
Granite	25,539	4,741.81	729,366	62,366	70,832	.....	551,343
Jefferson	13,596	2,850.11	186,790	331,910	1,491,080	.....	288,792
Lewis and Clark	2,650	1,666.08	36,844	12,146	213,943	.....	67,992
Lincoln	35	13.87	402	.....	21,747	.....	1,486
Madison	3,024	5,523.92	31,320	21,238	133,531	.....	142,274
Meagher	5	.....	.....	1,333	.....	.....	207
Missoula	671	17.32	13,856	90,329	107,764	.....	27,469
Powell	2,158	1,101.52	60,521	126,882	30,012	.....	80,313
Ravalli	54	8.74	325	5,070	3,301	.....	1,308
Sanders	1,221	102.82	17,005	84,732	310,772	.....	39,203
Silver Bow	703,777	9,666.53	3,283,796	71,840,007	116,679	27,242	13,325,099
Total	811,765	61,423.64	4,626,898	73,129,317	3,894,254	77,241	15,575,103
Subdivision by kinds of ore:							
Dry or siliceous	103,185	51,767.08	1,218,746	672,564	167,427	.....	1,917,858
Copper	692,701	7,673.23	3,004,111	72,306,004	20,456	.....	13,181,434
Lead	14,697	1,944.51	385,817	86,666	3,423,048	.....	437,277
Zinc	128	6.00	3,667	.....	.....	77,241	6,665
Copper-lead	1,054	32.82	14,557	64,083	283,323	.....	31,869

Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Montana, 1911–1913.

Kind of crude ore.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine ozs. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1911	72,135	$14.54	18.16	0.19	0.95	.....	$25.50
1912	76,648	11.82	15.28	.69	.33	.....	23.79
1913	103,185	10.37	11.81	.33	.08	.....	18.59
Copper:							
1911	566,044	.30	4.48	6.43	.....	.....	18.75
1912	753,381	.22	3.46	5.54	.....	.....	20.63
1913	692,701	.23	4.34	5.22	.....	.....	19.03
Lead:							
1911	6,419	7.81	25.99	.27	16.46	.....	36.95
1912	7,380	4.25	24.48	.29	14.75	.....	33.54
1913	14,697	2.73	26.25	.30	11.65	.....	29.75
Zinc:							
1912	95	.....	.....	.....	.....	37.26	51.42
1913	128	.97	28.64	.....	.....	30.17	52.06
Copper-lead:							
1911	1,177	.86	77.30	4.43	33.57	.....	83.11
1912	1,788	1.18	45.13	3.30	19.02	.....	56.95
1913	1,954	.64	13.81	3.04	13.44	.....	30.24
Lead-zinc:							
1911	128	.....	.....	.....	6.81	29.69	39.98
1912	91	.....	31.26	.....	21.93	30.51	81.07

A classification of kinds of crude ore shipped to the smelters, separated into oxidized and sulphides with average content, is shown in the two following tables:

Oxidized and sulphide crude ores, by kinds, including mixed dry ores and carbonate ores produced in Montana and shipped to smelters in 1913.

Kind of ore.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous ore	103,185	51,767.08	1,218,746	672,564	167,427	.....	$1,917,858
Copper:							
Oxidized	21,881	288.89	9,987	1,753,043	1,196	.....	283,779
Sulphide	670,820	7,384.34	2,994,124	70,552,961	19,260	.....	12,897,655
Lead:							
Oxidized	3,987	820.65	70,462	1,752	902,041	.....	99,484
Sulphide	10,710	1,123.86	315,355	84,914	2,521,007	.....	337,793
Zinc:							
Oxidized	77	.....	.....	.....	.....	49,999	2,800
Sulphide	51	6.00	3,667	.....	.....	27,242	3,865
Copper-lead:							
Oxidized	12	8.74	161	971	3,301	.....	574
Sulphide	1,042	24.08	14,396	63,112	280,022	.....	31,295
Total	811,765	61,423.64	4,626,898	73,129,317	3,894,254	77,241	15,575,103

Oxidized and sulphide crude ores, averages per ton, by kinds, produced in Montana and shipped to smelters in 1913, compared with 1912.

Kind of ore.	Quantity.	Average metallic content.					
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Fine ounces per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1912	76,648	0.57	15.28	0.69	0.33	.....	$23.79
1913	103,185	.50	11.81	.33	.08	.....	18.59
Copper:							
Oxidized—							
1912	13,453	.01	.86	4.42	.....	.....	15.32
1913	21,881	.01	.46	4.01	.....	.....	12.97
Sulphide—							
1912	739,928	.01	3.50	5.56	.....	.....	20.73
1913	670,820	.01	4.46	5.25	.....	.....	19.23
Lead:							
Oxidized—							
1912	3,457	.26	17.96	.40	10.56	.....	27.26
1913	3,987	.20	17.67	.....	11.44	.....	24.95
Sulphide—							
1912	3,923	.16	30.23	.19	18.45	.....	39.08
1913	10,710	.10	29.44	.40	11.77	.....	31.54
Zinc:							
Oxidized—							
1912	27	.....	.....	.....	.....	28.33	39.11
1913	77	.....	.....	.....	.....	32.47	36.36
Sulphide—							
1912	68	.....	.....	.....	.....	40.80	56.31
1913	51	.12	71.90	.....	.....	26.71	75.76
Copper-lead:							
Oxidized—							
1912	949	.05	73.11	3.50	28.51	.....	83.27
1913	12	.73	13.42	4.05	13.75	.....	47.83
Sulphide—							
1912	839	.06	13.47	3.08	8.29	.....	27.19
1913	1,042	.02	13.81	3.03	13.44	.....	30.03
Lead-zinc:							
Sulphide—							
1912	91	.....	31.26	.....	21.93	30.52	81.09
Total, 1912	839,383	.06	4.81	5.04	.20	.007	21.12
1913	811,765	.08	5.70	4.50	.24	.004	19.18

PRODUCTION BY COUNTIES.

GENERAL STATEMENT.

A table of the State output by counties in 1913, giving the metallic yield of each metal with total value, follows; also table showing tonnages and average value by counties, compared for 1912 and 1913, a table of the statistics of placer mines, and a review of the mining industry for each county and each producing mining district.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1913, by counties.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.		
	Quantity.	Value.	Quantity.	Value.		Quantity.	Value.
	Fine ozs.		*Fine ozs.*			*Fine ozs.*	
Beaverhead	132.02	$2,729	1,161.58	$24,012	$26,741	47,489	$28,683
Blaine			13,762.54	284,497	284,497	24,997	15,098
Broadwater	171.97	3,555	17,510.16	361,967	365,522	12,101	7,309
Cascade	3.63	75	259.19	5,358	5,433	292,266	176,529
Deer Lodge			13,209.57	273,066	273,066	13,911	8,402
Fergus			22,238.62	459,713	459,713	9,939	6,003
Granite	936.39	19,357	4,931.35	101,940	121,297	729,777	440,785
Jefferson	102.12	2,111	3,000.46	62,025	64,136	227,764	137,569
Lewis and Clark	1,145.13	23,672	6,275.06	129,717	153,389	51,444	31,072
Lincoln	4.89	101	113.48	2,346	2,447	414	250
Madison	33,458.62	691,651	8,646.83	178,746	870,397	82,453	49,802
Meagher	37.44	774			774	6	4
Missoula	702.74	14,527	421.30	8,709	23,236	36,894	22,284
Park	123.55	2,554			2,554	16	10
Powell	1,148.04	23,732	1,119.01	23,132	46,864	60,634	36,623
Ravalli	502.28	10,383	18.57	384	10,767	359	217
Sanders	27.57	570	110.54	2,285	2,855	17,012	10,275
Silver Bow	252.08	5,211	37,468.04	774,533	779,744	12,211,725	7,375,882
Total	38,748.47	801,002	130,246.30	2,692,430	3,493,432	13,819,201	8,346,797

Mine production of gold, silver, copper, lead, and zinc in Montana, in 1913, by counties.

County.	Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Beaverhead	65,682	$10,181	284,175	$12,504			$78,109
Blaine							299,595
Broadwater	398,791	61,813	55,281	2,432			437,076
Cascade	3,717	576	3,179,501	139,898	4,510	$253	322,689
Deer Lodge	94,844	14,701					296,169
Fergus	1,073	166	17,457	768	49,999	2,800	469,450
Granite	362,366	56,167	70,832	3,117			621,366
Jefferson	874,164	135,495	1,519,768	66,870	10,501	588	404,658
Lewis and Clark	12,176	1,887	223,193	9,820			196,168
Lincoln			21,747	957			3,654
Madison	25,983	4,027	262,490	11,550			935,776
Meagher	1,333	207					985
Missoula	90,329	14,001	415,073	18,263	78,999	4,424	82,208
Park							2,564
Powell	126,882	19,667	30,012	1,320			104,474
Ravalli	5,070	786	3,301	145			11,915
Sanders	84,732	13,133	310,772	13,674			39,937
Silver Bow	285,681,558	44,280,641	4,542,225	199,858	88,529,074	4,957,628	57,593,753
Total	287,828,699	44,613,448	10,935,827	481,176	88,673,083	4,965,693	61,900,546

Tonnage of ore sold or treated, number of mines producing, and avergae value per tons of ores in Montana in 1912 and 1913, by counties.

County.	Ore sold or treated (short tons).		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	1913	Increase (+) or decrease (−).	1912	1913	1912	1913	1912	1913
Beaverhead	4,405	+ 2,618	16	7	$96.27	$17.11	$74.26	$11.96
Blaine	80,664	− 1,897	2	5	5.48	3.71	5.48	3.71
Broadwater	18,132	− 2,065	32	31	20.67	23.91	18.22	20.36
Cascade	13,600	+ 6,194	14	15	25.93	23.72	12.05	13.37
Deer Lodge	33,266	+ 31,452	8	4	14.25	8.90	14.25	8.46
Fergus	55,310	− 13,416	9	13	6.54	8.49	6.52	8.42
Granite	37,988	+ 27,190	33	27	36.08	15.84	33.17	14.28
Jefferson	44,149	+ 1,836	53	55	16.32	9.12	11.51	4.52
Lewis and Clark	25,377	− 11,466	52	52	6.34	6.79	6.11	6.33
Lincoln	125	− 8,594	4	2	9.16	28.42	2.99	20.77
Madison	17,248	− 4,441	103	105	9.14	13.98	8.68	13.08
Meagher	5	− 28	2	1	39.66	41.40	19.06	.....
Missoula	13,836	+ 11,474	6	7	4.51	4.89	3.66	2.24
Park	.....	− 179	6	.....	10.90	.....	10.90	.....
Powell	2,177	+ 220	20	18	35.47	37.06	26.37	27.42
Ravalli	66	+ 12	2	3	9.16	22.92	9.16	8.82
Sanders	1,240	+ 449	4	7	26.98	31.75	8.06	10.13
Silver Bow	5,612,530	+368,595	86	78	11.54	10.26	1.48	1.45
Total	5,960,118	+407,954	452	430	11.52	10.25	1.92	1.85

[a] Value per ton, placer product excluded.

Number of producing placer mines and production in Montana in 1912 and 1913, by counties.

County.	1912						1913					
	Hydraulic, dry, and sluicing.	Dredging.	Drift.	Gold.	Silver.	Total value.	Hydraulic, dry, and sluicing.	Dredging.	Drift.	Gold.	Silver.	Total value.
				Value.	*Fine ounces.*					*Value.*	*Fine ounces.*	
Beaverhead	4	....	....	$2,888	15	$2,897	7	....	....	$2,729	11	$2,736
Broadwater	6	....	....	3,771	19	3,783	9	....	1	3,555	24	3,569
Cascade	.....	....	....	.....	.....	.....	1	....	....	75	2	76
Deer Lodge	1	....	....	213	2	214	.....	....	....	.....	.....	.....
Fergus	1	....	....	61	.....	61	.....	....	....	.....	.....	.....
Gallatin	1	....	....	124	.....	124	.....	....	....	.....	.....	.....
Granite	5	....	....	2,317	14	2,326	6	....	....	19,357	270	19,520
Jefferson	10	....	....	2,125	18	2,136	10	....	....	2,111	18	2,122
Lewis and Clark	35	1	1	48,204	431	48,469	15	1	2	23,672	191	23,787
Lincoln	3	....	....	4,859	15	4,868	1	....	....	101	.....	101
Madison	12	1	....	689,197	5,094	692,330	15	1	....	691,651	4,880	694,598
Meagher	4	....	....	494	2	495	3	....	....	774	6	778
Missoula	24	1	1	17,479	44	17,506	21	....	....	14,527	33	14,547
Park	4	....	....	717	6	721	4	....	....	2,554	16	2,564
Powell	25	....	....	26,706	168	26,809	21	....	1	23,732	111	23,799
Ravalli	4	....	....	5,857	17	5,868	2	....	....	10,383	31	10,402
Sanders	.....	....	....	.....	.....	.....	1	....	....	570	3	572
Silver Bow	8	....	....	1,407	7	1,411	5	....	1	5,211	27	5,227
Total	147	3	2	806,419	5,852	810,018	121	2	5	801,002	5,623	804,398

BEAVERHEAD COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Beaverhead County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	
1912	20	1,787	$81,814	87,454	83,580	567,484	$174,926
1913	14	4,405	26,741	47,489	65,681	284,175	78,109
Increase (+) or decrease (−) in 1913		+2,618	−55,073	−39,965	−17,899	−283,309	−96,817

[a] Includes placer production.

The ore output of the county increased from 1,787 tons in 1912 to 4,405 tons in 1913, but the value of the metals recovered from ores decreased from $174,926 in 1912 to $75,373 in 1913. The greater part of the ore was of milling grade, producing lead concentrate. There were 723 tons shipped directly to the smelters containing gold, silver, copper, and lead, valued at $60,643, or an average value per ton of $83.88. Lead ore predominated, aggregating 4,079 tons; siliceous ore amounted to 244 tons; and copper ore to 82 tons. The placer bullion produced contained $2,729 in gold and 11 ounces of silver, against a yield of $2,888 in gold and 15 ounces of silver in 1912. An electric plant was completed during 1913 to furnish power to the old Hecla mine at Argenta, which yielded several millions in early days and has been reopened. Mining in this county was more active in 1913 than for years, several properties being worked in the Blue Wing and the Bannack districts. The history, geology, and description of the ore deposits of many districts are given in a paper [1] published recently by the Survey.

Argenta district.[2]—A small shipment of copper sulphide ore carrying silver and a small quantity of gold was produced from the Jack Rabbit claim.

Bannock district.[3]—One deep mine and 5 placers yielded ore and bullion valued at $27,383. All of the ore, aggregating 188 tons, and containing gold, silver, and a little copper, was shipped directly to the smelter. The placer production amounted to $2,402 in gold and 9 ounces of silver.

Beaverhead or Bloody Dick district.—No production of ore was reported from this district.

Blue Wing district.[4]—A small output of siliceous silver ore containing a little gold and a trace of copper was shipped from the New Departure mine by lessees.

Bryant district.[5]—Two producers reported the production of 4,057 tons of ore, the larger part of which was milled and produced concentrates containing gold, silver, copper, and lead. One of the famous producers in the district, the Hecla Co., also operates the Atlantis, True Fissure, Trapper, and Cleve properties. The 20-stamp concentration mill on the property was finished in October. Both mine and mill have been supplied with electrical equipment.

[1] Winchell, A. N., Mining districts of the Dillon quadrangle, Montana, and adjacent areas: U. S. Geol. Survey Bull. 574, pp. 61–86, 1914.
[2] Idem, p. 65. [3] Idem, p. 72. [4] Idem, p. 69. [5] Idem, p. 79.

Nogo district.—Lead sulphide ore containing gold, silver, and a trace of copper was shipped from the Millionaire and Red Rock lode.

Polaris district.—No shipments of ore were reported from this district in 1913. The Survey bulletin referred to [1] fully describes the district.

Utopia district.[2]—The Indian Queen, a producer of copper sulphide ore carrying silver and a little gold, was the only mine reporting.

BLAINE COUNTY.

The output of 80,664 tons of siliceous gold ore, the yield of 5 producers in 1913, was 1,897 tons less than was mined by 2 producers in Blaine County in 1912.

Little Rockies district.—Shipments from the Mint and Ruby Gulch, and a small production from the August property comprise the output of the district. In October the 300-ton cyanide plant of the Ruby Gulch Mining Co. was destroyed by fire. A new plant is under construction and is to have a capacity of 600 tons of ore daily. The mine is opened by a tunnel 2,700 feet long. The Ethel property of the Beaver Creek Mining Co. was a producer of ore, which was treated in the 280-ton cyanide plant on the property. This property is opened by a tunnel 600 feet long and part of the surface is worked with steam shovel. The property was operated about three months during 1913.

BROADWATER COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Broadwater County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	
1912	38	20,197	$362,306	15,431	285,460	52,541	$421,261
1913	41	18,132	365,522	12,101	398,791	55,281	437,076
Increase (+) or decrease (−) in 1913		−2,065	+3,216	−3,330	+113,331	+2,740	+15,815

[a] Includes placer production.

Thirty-one deep mine producers reported the production of 18,132 tons of ore, which was 2,065 tons less than was produced by 32 producers in 1912. The total average value per ton increased from $20.67 in 1912 to $23.91 in 1913, and the gold and silver value per ton increased from $18.22 to $20.36 in 1913. The greater part of the ore was of shipping grade and aggregated 17,966 tons, containing gold, silver, copper, and lead, valued at $426,588, or an average value per ton of $23.74. At milling plants 159 tons were concentrated, yielding a lead concentrate averaging $56.19 per ton. Only 7 tons were reported to have been treated at gold and silver mills, producing bullion valued at $3,885. Ten placers reported an output of $3,555 in gold and 24 ounces of silver.

Backer or Diamond City district.—The 1-stamp mill operated by a gasoline engine on the Slim Jim property treated a small quantity of ore producing gold bullion. The tailings from the mill, which are very rich in gold, are saved and shipped to the smelter.

[1] Winchell, A. N., op. cit., p. 76.

[2] Idem, p. 61.

Beaver Creek district.—Fourteen deep mines produced 480 tons of ore, containing $13,860 in gold, 4,296 ounces of silver, 2,282 poundsof copper, and 47,063 pounds of lead, valued in all at $18,879, or an average per ton of $39.33. The output in 1912 amounted to 888 tons, averaging $41.40 per ton. The principal producers were the Iron Age and Custer groups, Cynosure, East Pacific Eclipse, Mary V., and Martha Washington.

Cedar Plains district.[1]—The output from 8 deep mines, the same number reporting in 1912, aggregated 17,575 tons, containing $342,011 in gold, 7,334 ounces of silver, 396,509 pounds of copper, valued in all at $407,900, or an average value per ton of $23.21. The Keating mine is opened to the eighth level and was the largest producer, yielding iron sulphide ore in which there is from 25 to 35 per cent of iron and 20 to 40 per cent of silica. This ore has averaged nearly 1 ounce of gold per ton. The Ohio Keating, producing similar ore, the Hidden Treasure, Gopher, and Copper King had important shipments. The railroad with which this district was to be equipped has not been finished further than the grading of the roadbed from Three Forks.

Deep Creek district.—The Big A and Big W placers reported gold bullion valued at $17.97 per ounce, of which a small production was made in 1913.

Park district.—Eight deep mines and 6 placers reported production. The total output contained $4,193 in gold, 375 ounces of silver, and 8,218 pounds of lead, valued in all at $4,781. The ore containing these values aggregated 71 tons, all of which, with the exception of 1 ton, was shipped directly to the smelter. The placers produced $2,102 in gold and 12 ounces of silver. The deep-mine producers were the Marietta, Florence & New Year, and Little Giant. The principal placer producers were the Wilson and the Metropolitan.

Bar Gulch district.—A small placer production was reported from the Anaconda claim, which was worked part of the year.

CASCADE COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Cascade County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1912	14	7,406	$4,037	138,608	6,379	2,259,494	.....	$192,011
1913	16	13,600	[a] 5,433	[a] 292,266	3,717	3,179,501	4,510	322,689
Increase (+) or decrease (−) in 1913		+6,194	+1,396	+153,658	−2,662	+920,007	+4,510	+130,678

[a] Includes placer production.

The mine output of 13,600 tons of ore in 1913, produced by 15 producers, was 6,194 tons greater than the output made by 14 producers in 1912. A little over half of the ore was concentrated, producing a lead concentrate. There were also shipped to the smelters 6,220 tons of crude lead ore containing 156.43 ounces of gold, 202,376 ounces of

[1] Winchell, A. N., op. cit., pp. 172–182.

silver, 3,353 pounds of copper, and 162,111 pounds of lead, valued in all at $177,121, or an average value per ton of $28.48. The larger part of the ore produced, or 13,404 tons, was lead ore. There was also 43 tons of siliceous ore, 5 tons of copper ore, and 148 tons of lead-zinc ore produced. The last named yielded lead concentrate and zinc concentrate. One producer reported a small output of placer gold.

Montana district.—Ore aggregating 13,600 tons was produced from 15 deep mines. The larger part was concentrated, yielding 2,962 tons of concentrates which contained silver, gold, and a trace of copper. One property produced lead-zinc ore, which was concentrated. There were shipped directly to the smelter 6,220 tons of crude ore carrying gold, silver, and copper values. The bulk of the lead produced in the district was contained in the concentrates. The Barker mines at Monarch produced the larger part of the ore, which was concentrated. The ores of shipping grade were the product of the Big Seven, Fitzpatrick, Broadwater, Hegener, Lexington, London, Montana, Liberty, Moulton, Queen of the Hills, Ripple, and Silver Belt properties.

DEER LODGE COUNTY.

The production of ore from 4 deep-mine producers was 33,266 tons. This quantity is 31,452 tons greater than that produced by 8 operators in 1912. The total average value per ton decreased from $14.25 to $8.90, and the gold and silver value in this ore decreased from $14.25 to $8.46 in 1913. All of the ore, with the exception of 25 tons, was of smelting grade, averaging per ton $8.89, most of which was for the gold content. Nearly all of the ore produced in 1913 was oxidized iron ore. No placer output was reported.

Georgetown district.—From 4 properties 33,266 tons of ore, all of which, with the exception of 25 tons, was oxidized iron ore, carrying values in gold, were shipped to the smelters chiefly for use as flux. The important producers of shipping ore were the Southern Cross, Holdfast, and Orofino mines. The Southern Cross mine is operated by the Anaconda Copper Mining Co., which shipped the first carload to the Washoe smelter on April 9, 1913, and shipments have been continuous since that time. The shaft was sunk on the Southern Cross property to the 500-foot level, where crosscutting is progressing.

FERGUS COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Fergus County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1912	10	68,726	$441,082	11,058	274	11,863	15,301	$449,518
1913	13	55,310	459,713	9,939	1,073	17,457	49,999	469,450
Increase (+) or decrease (−) in 1913		−13,416	+18,631	−1,119	+799	+5,594	+34,698	+19,932

[a] Includes placer production.

Reports from 13 producers showed an output of 55,310 tons of ore. This was 13,416 tons less than was reported from 9 deep mines in 1912. The total value of the ore increased from $6.54 to $8.40 per ton. The gold and silver value per ton of this ore was $6.52 in 1912 and $8.42 in 1913. The greater part of the ore produced in the county was treated by the cyanidation process, and 817 tons were shipped directly to the smelter. All of the ore produced was siliceous in character, with the exception of 38 tons of lead ore and 77 tons of zinc ore. No placer production was reported.

North Moccasin district.—Two operators reported the treatment of 49,876 tons of ore by the cyanidation process, which yielded gold and silver bullion. The mill of the Barnes King Development Co., operating the North Moccasin mine, was enlarged and operated the entire year on siliceous gold ores. A clean up of gold precipitates was made from one other mill in the district.

Warm Springs district.—Eleven deep-mine producers reported the production of 5,434 tons of ore containing $96,443 in gold, 7,148 ounces of silver, 1,073 pounds of copper, 17,457 pounds of lead, and 49,999 pounds of zinc, valued in all at $104,494. The properties for which reports were received were the Maginnis and Cumberland mines, on which lessees operated, and the Spotted Horse and War Eagle. The last mine produced zinc ore.

GRANITE COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Granite County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	
1912	38	10,798	$105,376	414,831	166,312	89,597	$391,971
1913	33	37,988	121,297	729,777	362,366	70,832	621,366
Increase (+) or decrease (—) in 1913		+27,190	+15,921	+314,946	+196,054	—18,765	+229,395

[a] Includes placer production.

Twenty-seven producers reported 37,988 tons of ore, which was 27,190 tons greater than the output by 33 producers in 1912. The total average value per ton of the ore decreased from $36.08 to $15.84, and the gold and silver value from $33.17 to $14.28 in 1913. The 25,539 tons of ore of shipping grade contained gold, silver, copper, and lead, valued at $551,343, or an average value of $21.59 per ton. There were 253 tons of ore treated at gold and silver mills and 12,000 tons of copper ore treated by a leaching process, yielding copper bullion, which was reported to have been shipped to an eastern refinery. There were 6 placers reporting an output of $19,357 in gold and 270 ounces of silver.

Alps district.—A Kinkead amalgamation mill was operated on ores produced from the Rainy Day property, and a small quantity of gold bullion was produced.

First Chance district.—Ore aggregating 554 tons was produced from 6 deep mines in the district. All of the ore was of shipping grade and contained $36,456 in gold, 2,479 ounces of silver, 9,845 pounds of

copper, with a total value of $39,479. The larger part of the ore was from the Magone & Anderson property. Other producers were the Shamrock, Peacock, Nancy Hanks, Fourth of July, and International. The placers yielded $1,076 in gold and 6 ounces of silver.

Flint Creek district.—All of the ore mined in this district, aggregating 24,857 tons, was shipped directly to the smelters and contained 2,970.81 ounces of gold, 721,424 ounces of silver, 51,970 pounds of copper, and 70,832 pounds of lead. The Granite Mountain mine, the Hope, Combination, Eagle, Londonderry, Hobo, and Pocahontas were producers.

Rock Creek district.—Gold bullion was produced from two placer properties in the district, one of them owned by the Basin Mining Co.

South Boulder district.—The output of the deep mines in this district was 12,377 tons of ore, containing $1,419 in gold, 5,558 ounces of silver, and 300,551 pounds of copper. The total value of the production, including the gold from one placer, was $51,496. The principal productions were reported from the North Star, Mount Royal, and Sunday properties. The North Star mine is equipped with a 400-ton sulphuric acid leaching plant for the treatment of copper ores. According to the report of the company the ores recently encountered are sulphides, and the plant is being equipped with concentrating machinery.

JEFFERSON COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Jefferson County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1912	63	42,313	$175,361	510,509	776,072	1,589,588	55,542	$392,739
1913	66	44,149	64,136	227,764	874,164	1,519,768	10,501	404,658
Increase (+) or decrease (−) in 1913		+1,836	−111,225	−282,745	+98,092	−69,820	−45,041	−288,081

[a] Includes placer production.

The production of ore reported from 55 deep mines aggregated 44,149 tons, or 1,836 tons more than the production of 53 producers in 1912. The total average value per ton of the ore decreased from $16.32 in 1912 to $9.12 in 1913, and the gold and silver value per ton from $11.51 to $4.52. The greater part of the ore was milled and produced concentrates containing gold, silver, copper, lead, and zinc. There were 4,891 tons of concentrates produced valued at $112,740, or an average value per ton of $23.05. The crude ore of shipping grade amounted to 13,596 tons containing 2,850.11 ounces of gold, 186,790 ounces of silver, 331,910 pounds of copper, and 1,491,080 pounds of lead, valued in all at $288,792, or an average value of $21.24 per ton. There were only 36 tons of ore treated at gold and silver mills. Ten mines reported placer production amounting to $2,111 in gold and 18 ounces of silver.

Amazon district.—Three deep-mine operators reported a production of 130 tons of ore containing gold, silver, copper, and lead. The Mono and Mayflower properties were operated.

Boulder district.—The operators of 4 deep mines reported the production of 424 tons of ore containing $1,048 in gold, 6,624 ounces of silver, 10,956 pounds of copper, and 55,378 pounds of lead, and 10,501 pounds of zinc, valued in all at $9,772. The placer output amounted to $946 in gold and 9 ounces of silver. The deep mines in operation were the Baltimore, St. John, and Silver Star. The placers were the Little Boulder and the Lulla.

Cataract district (including Lowland).—Operators of 13 deep mines shipped directly to the smelters 3,439 tons of ore containing 832.17 ounces of gold, 67,598 ounces of silver, 103,544 pounds of copper, and 606,861 pounds of lead, valued in all at $100,845, or an average value per ton of $29.28. This production includes gold and silver from a few tons of tailings concentrated. Besides this, one placer shipped bullion containing $100 in gold. The Bullion, Grey Eagle, Crystal, and Comet were operated by the Northwestern Metals Co., and other producing mines were the Corbet, West Rumley, Kit Carson, Ruby and Columbia, and Early Riser.

Colorado district.—The largest ore producers of the district were the Bertha, the Mount Washington, the Blue Bird, and the Alta-Gregory. The bulk of the ore was concentrated, yielding 4,815 tons of copper concentrates which contained gold and silver. There were shipped directly to the smelters 4,985 tons of ore, containing 604.54 ounces of gold, 99,542 ounces of silver, 136,282 pounds of copper, and 739,128 pounds of lead. The total value of the production of the district amounted to $235,099, including $116 in placer gold.

Elkhorn district.—Most of the ore mined in the district was oxidized iron ore shipped directly to the smelters for flux. The largest part of it came from the Golden Curry mine, operated by lessees. The total output of the district aggregated 4,198 tons, containing $18,890 in gold, 8,673 ounces of silver, 73,087 pounds of copper, and 36,680 pounds of lead, valued in all at $37,072. The Dolcoth, Queen, Sophia, Heagan, Saracen, and Union were also producers in 1913.

Homestake district.—Oxidized ores carrying gold and silver were shipped from the Sunset National and Hackensack properties.

Lump Gulch district.—Reports received from 5 deep mines and 1 placer gave an output valued at $8,657. There were 239 tons of ore shipped directly to the smelters, containing gold, silver, copper, and lead, and 10 tons produced gold and silver bullion, the result of amalgamation tests. The properties operated were the Bell, Carbonate Chief, and Liverpool. One placer producer reported the production of $267 in gold and 5 ounces of silver.

Mitchell Gulch district.—The total value of the output of 2 deep mines and 1 placer amounted to $1,472. The ore shipped aggregated 89 tons and contained gold, silver, and lead. The properties which are reported to have produced were the Dobler and Last Chance.

Whitehall district.—This district is described in a paper[1] published by the Survey. Six deep mine producers in 1913 reported 270 tons of ore, containing $4,209 in gold, 1,138 ounces of silver, 7,447 pounds of copper, and 42,493 pounds of lead. The total value, including the production of one placer, amounted to $8,386. Ore was produced from the Golden Sunlight, Petaluma, and four other properties.

[1] Winchell, A. N., Mining districts of the Dillon quadrangle, Montana, and adjacent areas: U. S. Geol. Survey Bull. 574, pp. 97–101, 1914.

LEWIS AND CLARK COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Lewis and Clark County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
PLACERS.		*Short tons.*	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	37	.....	$48,204	431	.....	.....	$48,469
1913	18	.....	23,672	191	.....	.....	23,787
DEEP MINES.							
1912	52	36,843	197,695	44,706	17,075	120,994	233,451
1913	52	25,377	129,717	51,253	12,176	223,193	172,381
Increase (+) or decrease (−) in 1913		−11,466	−92,510	+6,307	−4,899	+102,199	−85,752

From 52 deep mines a production was reported of 25,377 tons of ore, which is 11,466 tons less than was reported by the same number of producers in 1912. The total average value per ton of this ore increased slightly from $6.34 to $6.79 and the gold and silver value from $6.11 to $6.33 per ton. The larger part of the ore, 17,707 tons, was treated by the amalgamation and cyanidation processes and yielded $93,801 in gold and 13,959 ounces of silver, with a total value of $102,232. This ore also produced 49 tons of concentrates containing gold, silver, lead, and a trace of copper. Crude shipping ore aggregating 2,650 tons, contained gold, silver, copper, and lead, valued at $67,992, or an average value of $25.66 per ton. There were only three kinds of ore produced, the largest part, or 24,587 tons, was siliceous ore; 74 tons was copper ore, and 716 tons was lead ore. The placer output reported by 18 producers amounted to $23,672 in gold and 191 ounces of silver.

Bald Butte district.—The principal production of the district consisted of concentrates and gold and silver bullion, the yield of the Bald Butte property, which is equipped with a 40-stamp mill and was operated a little over a month during the year.

Dry Gulch district.—The total value of the district output amounted to $12,555, of which the principal part was for placer bullion, the output of 4 producers. There was shipped from the district 16 tons of ore containing lead. The largest producer of gold was the Magpie placer, operated by dredging for about six months, during which time about 255,000 cubic yards of placer material was handled.

Gould district.—The Rocky Mountain and Gould properties were operated, producing ore which was treated by cyanidation and amalgamation, and yielded gold and silver bullion and precipitates.

Greenhorn district.—Ore milled in the 30-ton cyanide plant of the Umatilla property and that from the Blue Cloud mine, with a small production from the Greenhorn placers, amounted in value to $800.

Helena district.—The reports of 7 deep mine operators showed a production of 376 tons of ore carrying gold, silver, and a small quantity of lead, which, with the placer production of 3 operators, amounted to a total value of $9,218. A small lot of bullion was recovered from ores treated by amalgamation at the Arrowhead property.

Jefferson Gulch district.—The Handicap and Mukden properties produced gold and silver bullion through the operation of a 10-stamp mill.

Lincoln district.—The only production recorded was placer gold from the Harvey and the old Billy Williams properties, situated in Sauer Kraut gulch and in McClellan Gulch, respectively.

Ottawa district.—There were 20 deep mine producers reporting 17,558 tons of ore, the bulk of which, or 12,454 tons, was treated by cyanidation and amalgamation, and produced gold and silver bullion. Eighty-four tons were shipped directly to the smelters. The total output of the district, including the production from 1 placer, amounted to $81,920. The most important producers were the Cruse & Bald Mountain property and the Drumlummon mine, operated by the St. Louis Mining & Milling Co., which closed down during the year on account of litigation. Old tailings along Canyon Creek were treated with the usual success by cyanidation, and the gold and silver precipitates shipped to the smelter.

Poorman district.—The output of the district consisted of gold and silver bullion produced from the operations of 2 placers.

Scratch Gravel district.—A small tonnage of lead ore containing silver was shipped from the Aster claim, and an important tonnage of lead ore containing gold, silver, and a little copper was shipped from the Franklin property. The Lexington property was also a producer of ore treated by amalgamation.

Seven Mile district.—The Silver King and Saginaw properties were producers of silver-lead ore containing traces of gold and copper.

Stemple district.—Ore containing gold and silver was treated in the 5-stamp mill on the Klondyke claim.

Springhill district.—The Skelly Gulch placers were not operated in 1913, but bullion shipped from previous operations was reported.

Unionville districts.—Lessees operated the Whitlatch property and succeeded in producing some ore of shipping grade containing gold and silver, and gold and silver bullion was produced from the short operation of the mill, during which time the property was being put in working shape for future production.

Vaughn district.—The total value of output of 7 deep mines and 2 placers amounted to $16,485. The deep mines produced 663 tons of ore containing gold, silver, copper, and lead, and the placers produced $4,786 in gold and 68 ounces of silver. Credited to the district is the ore output of the Caplice, Montana, Monte Cristo, Silver Cliff, and Valley Forge properties. The placers producing were the Dynamite and Perseverance.

LINCOLN COUNTY.

The output of the deep mines of this county was greatly decreased on account of the closing of the mines in the Libby district. There were only 125 tons of ore produced in 1913, against 8,719 tons reported in 1912. The total value per ton of the ore increased from $9.16 in 1912 to $28.42 in 1913, and the gold and silver value from $2.99 to $20.77 per ton. At an amalgamation mill 90 tons of siliceous ore were treated, and 35 tons of lead ore were shipped directly to the smelters.

Callahan Creek district.—The Banner & Bangle, also the Big Eight, were under development in 1913 and are being opened for the production of zinc and lead ores.

Libby district.—Mill bullion was shipped from the property of the Kalispell & Lincoln Mining Co., which is equipped with a 3-stamp amalgamation mill. There was also a small quantity of lead ore shipped from one other property in the district.

MADISON COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Madison County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
PLACERS.		*Short tons.*	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	13	.....	$689,197	5,094	.....	.....	$692,330
1913	16	.....	691,651	4,880	.....	.....	694,598
DEEP MINES.							
1912	103	21,689	163,397	40,378	19,840	152,323	198,359
1913	105	17,248	178,746	77,573	25,983	262,490	241,178
Increase (+) or decrease (−) in 1913		−4,441	+17,803	+36,981	+6,143	+110,162	+45,087

The output of ore made by 105 producers was 17,248 tons, which was 4,441 tons less than that produced by 103 operators in 1912. The total average value per ton of the ore increased from $9.14 in 1912 to $13.98 in 1913, and the gold and silver value of the ore from $8.68 to $13.08 per ton. The greater part of the ore, or 12,582 tons, was treated at gold and silver mills and yielded bullion containing $26,684 in gold and 26,805 ounces of silver, with a total value of $42,874. In addition, there were shipped to the smelters 3,024 tons of ore containing 5,523.92 ounces of gold, 31,320 ounces of silver, 21,238 pounds of copper, and 133,531 pounds of lead, valued in all at $142,274, or an average of $47.05 per ton. There were treated at concentration mills 1,642 tons of ore yielding 826 tons of concentrates containing 1,832.06 ounces of gold, 19,448 ounces of silver, 4,745 pounds of copper, and 128,959 pounds of lead, valued in all at $56,029, or an average of $67.83 value per ton of concentrates. Nearly all of the ore (15,120 tons) was dry or siliceous in character. There were also produced 2,008 tons of lead ore and 120 tons of copper ore. The placer output of 16 operators amounted to $691,651 in gold and 4,880 ounces of silver, having a total value of $694,598. The history, geology, and description of the ore deposits of many of the districts are described in Survey Bulletin 574 already cited.

Alder Gulch district.[1]—The reports of 12 deep mines show the production of 206 tons of ore, containing $3,065 in gold, 5,472 ounces of silver, 775 pounds of copper, and 30 pounds of lead. This output with that of the placers reported by 11 operators and consisting of of $689,499 in gold and 4,861 ounces of silver, amounted to $698,926. The bulk of the ore, 164 tons, containing gold, silver, and a small quantity of copper, was shipped directly to the smelters, and 42 tons were treated at a concentration mill. The placer production in 1912 was $687,863 in gold and 5,084 ounces of silver. The principal placer operations were carried on at Ruby by the Conrey Placer Co., which operated 4 dredgers.

[1] Winchell, A. N., op. cit., pp. 57–61.

Bone Basin district.—The Bonanza Fraction property yielded some iron sulphide ore containing gold, silver, and a little copper.

Lower Hot Springs district.[1]—From 12 deep mine producers 99 tons of ore were shipped containing $3,721 in gold, 181 ounces of silver, and 1,278 pounds of lead, and valued in all at $3,886, or an average value of $39.25 per ton. The Bessie May Queen, Birdie, Gold Reef, Valdez, and other smaller producers recorded production.

Mineral Hill district.[2]—Seven deep mine producers reported the output of 7,320 tons of ore containing $35,836 in gold, 2,061 ounces of silver, 2,871 pounds of copper, and 4,395 pounds of lead, valued in all at $37,720, or an average value of $5.15 per ton. The larger part of the ore, or 7,258 tons, was treated at milling plants and produced gold and silver bullion and concentrates containing principally gold with some silver, copper, and lead. There were 62 tons of ore shipped directly to the smelter containing gold, silver, copper, and lead. The principal producers were the Boss Tweed and Clipper mines, and smaller yields were made by the Garnet, Old Joe, Willow Creek, and Pony.

Norwegian district.[3]—The Gold Hill property was reported idle in 1913. Production of ore containing gold and silver with a trace of copper was reported from one property.

Rabbit (Rochester) district.[4]—The Emma, Cooper, Clifton, and Mount Rose properties yielded 287 tons of oxidized and sulphide ores of shipping grade, containing gold, silver, copper, and lead, valued in all at $8,775.

Ramshorn district.[5]—Four deep mine producers reported the production of 1,537 tons of ore, the larger part of which was milled. The total output of the district, including the placer production of 5 operators, was valued at $10,792. The deep mine properties producing were the Bedford, Cash Boy, Ellajay, and Mutt and Jeff.

Sheridan district.[6]—Ore was produced by 10 deep mine operators, amounting to 427 tons, which contained $7,295 in gold, 3,256 ounces of silver, and 3,810 pounds of copper, valued in all at $9,852. The largest production was of ore and bullion from the Tamarack property.

Silver Star district.[7]—There were 567 tons of ore produced by 12 operators containing $20,327 in gold, 828 ounces of silver, 5,856 pounds of copper, and 15,831 pounds of lead, valued in all at $22,432. The bulk of this ore (549 tons) was of shipping grade and a small tonnage was treated at milling plants by amalgamation. The principal production of ore came from the Broadway, Hudson, and Keystone properties.

Summit district.[8]—Fifteen deep mine producers reported 5,637 tons of ore containing $63,764 in gold, 50,489 ounces of silver, 1,688 pounds of copper, and 27 pounds of lead, valued in all at $94,522. Most of the ore, or 5,006 tons, was treated at milling plants, producing gold and silver bullion and 139 tons of concentrates containing gold, silver, and a small quantity of copper. There were 631 tons of ore shipped directly to the smelter. The Easton-Pacific property was the largest producer.

Tidal Wave district.[9]—All of the ore produced in the district, or 334 tons, was of shipping grade, and contained $11,636 in gold, 2,355

[1] Winchell, A. N., op. cit., pp. 110–116.
[2] Idem, pp. 118–121, 124.
[3] Idem, pp. 110–113.
[4] Idem, pp. 126–132.
[5] Idem, p. 138.
[6] Idem, pp. 132–135.
[7] Idem, pp. 139–144.
[8] Idem, pp. 162–168.
[9] Idem, pp. 145–147.

ounces of silver, 8,245 pounds of copper, and 20,910 pounds of lead, valued in all at $15,257, or an average of $45.68 per ton. The principal producers were the Iron Rod, Carolina, Keynote and Lone Tree, and Mountain View

Upper Hot Springs district.[1]—The Monitor and Revenue property, operated by a lessee, and the Lexington were the principal producers of 158 tons of ore, half of which was shipped directly to the smelter and the remainder treated by cyanidation. The total output of the district was valued at $6,176.

Washington Gulch district.[2]—In all there were 444 tons of ore produced by three mine operators in the district having a total value of $23,842 for the gold, silver, and a small output of copper. The larger part of the ore, or 325 tons, was of shipping grade and 119 tons were treated in a milling plant, producing gold and silver bullion. The producers were the George McKee, Lehigh, Missouri, and Tucker.

Wilmah district.—Copper ore containing a small quantity of silver and gold was mined from the Bismark property.

MEAGHER COUNTY.

The production of 5 tons of ore, containing copper, was reported by one operator in 1913. This is 28 tons less than was reported by 2 operators in 1912. The total average value per ton increased from $39.66 in 1912 to $41.40 in 1913. There was no gold or silver reported in the ore in 1913. The production by 3 placer operators amounted to $774 in gold and 6 ounces of silver.

Diamond district.—Copper ore was produced from the Jasper property, and two placers reported producing gold and silver bullion.

Elk Creek district.—One placer property produced a small amount of gold taken out in doing assessment work.

MISSOULA COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Missoula County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Placers.								
1912	26	.....	$17,479	44	.....	.....	.....	$17,506
1913	21	.....	14,527	33	.....	.....	.....	14,547
Deep mines.								
1912	6	2,362	8,260	648	10,710	5,337	.....	10,656
1913	7	13,836	8,709	36,861	90,329	415,073	78,999	67,661
Increase (+) or decrease (−) in 1913		+11,474	−2,503	+36,202	+79,619	+409,736	+78,999	+54,036

The operators of 7 properties reported mining 13,836 tons of ore, 11,474 tons more than was produced by 6 operators in 1912. The total average value per ton increased from $4.51 in 1912 to $4.89 in 1913, and the gold and silver value in this ore decreased from

[1] Winchell, A. N., of cit., pp. 110–116. [2] Idem, p. 113.

$3.66 per ton in 1912 to $2.24 per ton in 1913. Nearly all of the ore mined, or 10,361 tons, was treated at milling plants by concentration and yielded 440 tons of concentrates, containing 2 ounces of gold, 22,957 ounces of silver, 307,309 pounds of lead, and 78,999 pounds of zinc. Ore of shipping grade, aggregating 671 tons, contained 17.32 ounces of gold, 13,856 ounces of silver, 90,329 pounds of copper, and 107,764 pounds of lead. At gold and silver mills 204 tons of ore were treated by amalgamation and 2,600 tons of tailings were treated by cyanidation, yielding 401.98 ounces of gold and 48 ounces of silver. From placer operations $14,527 in gold and 33 ounces of silver were produced, as against a production in 1912 of $17,479 in gold and 44 ounces of silver.

Cedar, Quartz, and Trout Creek districts.—One deep mine and 16 placer producers reported an output valued at $22,314, the larger part of which consisted of placer bullion containing $11,679 in gold and 28 ounces of silver. In 1912 the placer output reported from 21 sources amounted to $14,129 in gold and 32 ounces of silver. Sulphide copper ore was shipped from the Amdor property, which was put in condition for production in 1913. Placer gold was produced from the property of the Cedar Creek Dredging Co. Other placers producing were the deep Gulch, Meadow Creek, Nellie, Ohio Gulch, California Creek, Blue Bird and Index, Windfall, Sunrise, Stockholm, and C. B. and Q.

Iron Mountain district.—All of the ore produced in the district was from the Iron Mountain Tunnel property and was milled in the concentration plant, which has a rated capacity of 100 tons daily, but is reported to be able to treat from 225 to 250 tons of the Iron Mountain ore. This mill is equipped with four MacQuisten tubes, by which some of the zinc concentrates are saved by the flotation process. The mine is electrically equipped and is opened by a shaft and tunnels.

Nine Mile district.—Five placers and 2 deep mines yielded an output valued at $11,190, all of which was for gold and silver. There were 2,804 tons of ore and tailings milled, yielding gold bullion by the amalgamation and cyanidation processes. The deep-mine producers were the Nine Mile and San Martina properties. The placers producing were the Chrysalis, Tom Tom, and Slide.

St. Regis district.—Copper ore containing gold and silver was shipped directly to the smelters from the St. Lawrence group, situated on the Montana and Idaho line.

Saltese district.— Ore containing copper, gold, and silver was shipped from the Bald Mountain property. A recent Survey bulletin[1] describes the district.

Spring Gulch district.—About 2 miles west of Keystone is situated the Little Pittsburg property, from which was shipped a small quantity of oxidized copper ore carrying silver and gold.

PARK COUNTY.

No production of ore was made in this county in 1913. In 1912 the county produced 179 tons of ore. Four placer operators in 1913 reported $2,554 in gold and 16 ounces of silver.

[1] Calkins, F. C., and Jones, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: U. S. Geol. Survey Bull. 540, pp. 167-211, 1914.

Cowles district.—The Boulder Basin Mining Co. shipped a small quantity of gold from testing and making improvements on the property.

Emigrant Creek district.—The Pittsburg property, near Chico, produced a small quantity of gold. There was one other producer whose output was estimated.

POWELL COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Powell County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
PLACERS.		*Short tons.*	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	25	.....	$26,706	168	.....	.....	$26,809
1913	22	.....	23,732	111	.....	.....	23,799
DEEP MINES.							
1912	20	1,957	24,585	43,936	96,369	42,456	69,417
1913	18	2,177	23,132	60,523	126,882	30,012	80,675
Increase (+) or decrease (−) in 1913.		+220	−4,427	+16,530	+30,513	−12,444	+8,248

Eighteen producers reported 2,177 tons of ore, which is 220 tons less than was produced by 20 operators in 1912. The total average value of the ore increased from $35.47 per ton in 1912 to $37.06 per ton in 1913, and the gold and silver value from $26.37 to $27.42 per ton. Ore of shipping grade amounted to 2,158 tons containing 1,101.52 ounces of gold, 60,521 ounces of silver, 126,882 pounds of copper, and 30,012 pounds of lead, with a total value of $80,313, or an average value of $37.22 per ton. At milling plants 19 tons of ore were treated, yielding $362 in gold and 2 ounces of silver. Of the ore produced, 1,846 tons were classed as copper ore, 286 tons as siliceous ore, and 45 tons as lead ore. There were 22 placers reporting gold valued at $23,732 and 111 ounces of silver.

Bear Gulch district.—During a short season when snow water only was available, the Alabama placer yielded a small quantity of gold having an average fineness of about 0.912.

Coloma district.—The Elk Creek hydraulic elevator was operated 108 days, during which time about 14,000 yards of placer material was treated, producing a small quantity of gold.

Copper Cliff district.—The Leonard mine, the only producer in this district, shipped copper ore carrying values in gold and silver. The property is opened by a shaft 100 feet deep and has 20 feet of drifts.

Deadwood Gulch district.—During 22 days of operation the McKeays placer produced a small quantity of gold by sluicing. This property is situated near the head of Deadwood Gulch.

Ontario district.—Copper-lead ore of shipping grade was produced in the district from 3 properties. One of the producers, the Dezielle group, was operated the entire year.

Ophir district.—The total value of the output of the district, reported by 11 deep mines and 8 placers, amounted to $65,723. Of this

value, the larger part was from ore containing $16,571 in gold, 52,055 ounces of silver, 95,264 pounds of copper, and 19,541 pounds of lead. All of the ore produced was shipped directly to the smelters, with the exception of 19 tons, which was treated at a gold and silver mill. The Julia property, operated by the Montana Clinton Mining Co., was the principal producer of ore, chiefly copper sulphide, containing silver, gold, and a small quantity of lead. Another deep-mine producer was the Victory, whose yield is mainly gold with a little silver, copper, and lead. The 8 placer producers made small shipments of bullion containing $2,078 in gold and 12 ounces of silver.

Pioneer district.—Four placers and 1 deep mine reported an output valued at $18,891. The larger part of this production is credited to the placers, among which were the Pioneer and the Friday.

Washington Gulch district.—Five placers produced $1,916 in gold and 11 ounces of silver. The principal producer was the Scotch Bar, worked by hydraulic and drift mining.

Zozell district.—Gold-silver ore was shipped from one property, the Emery Consolidated.

RAVALLI COUNTY.

Three deep mines reported the output of 66 tons of ore, which is 12 tons more than was reported by 2 producers in 1912. The total average value per ton of the ore increased from $9.16 in 1912 to $22.92 in 1913, and the gold and silver value decreased from $9.16 to $8.82 per ton. There were shipped directly to smelters 54 tons of ore containing gold, silver, copper, and lead, with an average value per ton of $24.22. One small lot of ore was treated at a milling plant and produced gold and silver bullion. The placer output reported by 2 producers amounted to $10,383 in gold and 31 ounces of silver.

Curlew district.—Lessees on the Curlew and Elizabeth properties produced a small quantity of lead ore containing gold, silver, and copper.

Hughes Creek district.—The output of the district consisted principally of placer gold. The most important operator was the Wood Placer Mining Co.

SANDERS COUNTY.

Seven operators reported 1,240 tons of ore, 449 tons more than was produced by 4 operators in 1912. The total average value per ton of the ore increased from $26.98 in 1912 to $31.75 in 1913, and the gold and silver value of this ore from $8.06 to $10.13 per ton. All of the ore, with the exception of 9 tons treated at a gold and silver mill, was shipped to the smelters and contained gold, silver, copper, and lead valued at $39,203, or an average value per ton of $31.85. The largest part of the tonnage produced in the county, or 1,042 tons, was copper-lead ore, 100 tons was copper ore, 22 tons was siliceous ore, and 76 tons was lead ore.

Revias Creek district.—The Dixon property near Dixon produced copper ore carrying good values in gold and a small quantity of silver.

Spring Gulch district.—Four producers, whose output was partly estimated, mined and shipped to the smelters 1,166 tons of ore containing $543 in gold, 16,409 ounces of silver, 70,037 pounds of copper,

and 310,660 pounds of lead, valued in all at $34,978, or an average per ton of $30.

Prospect Creek district.—Copper ore containing silver and a trace of gold was shipped from one property in the district.

Trout Creek district.—Gold-silver ore produced from 2 properties and bullion from 1 placer was reported in 1913.

SILVER BOW COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Silver Bow County, Mont., in 1912 and 1913.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1912....	94	5,243,935	$794,643	11,352,106	308,222,547	1,296,283	26,792,550	$60,539,927
1913....	84	5,612,530	779,744	12,211,725	285,681,558	4,542,225	88,529,074	57,593,753
Increase (+) or decrease (−) in 1913.		+368,595	−14,899	+859,619	−22,540,989	+3,245,942	+61,736,524	−2,946,174

[a] Includes placer production.

Ore produced in this county was mainly from the Butte or Summit Valley district, with smaller quantities produced in adjacent districts. There were 78 operators of deep mines reporting in 1913 a production of 5,612,530 tons of ore, which is 368,595 tons more than was reported by 86 producers in 1912. One large operator produced over 80 per cent of this output. The total average value of the ore decreased from $11.54 to $10.26 per ton, and the gold and silver in this ore remained about the same, decreasing from $1.48 per ton in 1912 to $1.45 per ton in 1913. The value of the gold produced from deep mines and placers amounted to $779,744 in 1913, as against $794,643 in 1912. The silver output, valued at $6,981,545 in 1912, increased to $7,375,882 in 1913. The value of the copper production decreased from $50,856,720 in 1912 to $44,280,641 in 1913. The value of the lead output increased from $58,333 in 1912 to $199,858 in 1913, and that of zinc from $1,848,686 in 1912 to $4,957,628 in 1913. In total value the entire output decreased from $60,539,927 in 1912 to $57,593,753 in 1913. Most of the ore mined was concentrated at milling plants situated at Butte, Anaconda, and Great Falls. From 4,876,896 tons of ore thus treated there were produced copper concentrates, lead concentrates, and zinc concentrates aggregating 1,524,594 tons containing $571,319 in gold, 8,910,667 ounces of silver, 205,103,581 pounds of copper, 4,425,546 pounds of lead, and 88,501,832 pounds of zinc, valued in all at $42,895,243, or an average value of $28.14 per ton of concentrates. The crude smelting ores amounted to 703,777 tons having a recoverable content of $199,825 in gold, 3,283,796 ounces of silver, 71,840,007 pounds of copper, 116,679 pounds of lead, and 27,242 pounds of zinc, valued in all at $13,325,099, or an average value per ton of $18.93. Gold and silver bullion was produced from 7,397 tons of ore treated at amalgamation mills, yielding $3,389 in gold and 17,235 ounces of silver, with a total value of $13,799. The production was classified as 5,287,215 tons

of copper ore, 296,940 tons of lead-zinc ore, 24,223 tons of siliceous ore, 3,763 tons of zinc ore, and 389 tons of lead ore. Placers operated in the county produced $5,211 in gold and 27 ounces of silver.

Divide Creek district (including Melrose district, Camp and Soap creeks).[1]—Six deep mines reported the shipment directly to smelters of 293 tons of ore containing $5,971 in gold, 462 ounces of silver, 32,500 pounds of copper, valued in all at $11,287. The Columbia and Clipper were the principal producers. Smaller productions were made from the Gold King, High Ridge, and Combination and Lincoln.

German Gulch district.—Purchasers of placer gold credited this district with an output of $3,024 in gold and 13 ounces of silver, as against an output in 1912 valued at $641 in gold and 3 ounces of silver.

Highland district.—The estimated output of one deep mine and two placers was $4,663 in gold and 19 ounces of silver. Part of this production was bullion, said to have been derived from the Tilton property, although it may not have been produced in 1913.

Summit Valley or Butte district.—Successful smelting in Montana of copper ores began in 1879, when the Colorado smelter was built at Butte. Several attempts at smelting were made as early as 1866, but during this period no ore was known to exist in Anaconda Hill; the Anaconda-Neversweat was not located until 1875. In 1864 the Parrot, Park, Original, and Gagnon claims were among the first located, and in 1874 development was begun on the Original claim. The ore produced was hauled 400 miles to Corinne, Utah, where some of it was smelted as early as 1871, when the Sanger smelter was built. This smelter was only operated for a limited time, and subsequently all of the ore was shipped by rail to various buyers of copper ore, and, although the ore was rich, carrying 35 per cent copper and not less than $50 in silver and gold, it is said that after all charges of freight and smelting were deducted there was nothing left to the producer.

The list[2] of smelters built for the treatment of Butte copper ores is as follows:

Smelters built for treatment of Butte copper ores.

	Started.	Closed.
Colorado & Montana Smelting Co	1879	1905.
Colusa Smelter (Montana Copper Co.)	1880	1892.
Clark's Colusa	1884	1893.
Colusa Parrot (Butte Reduction Works)	1885	1910.
Butte & Boston	1888	1905.
Montana Ore Purchasing Co	1892	1906.
Bell Smelter	1881	1882.
Anaconda Upper Works	1883	1902.
Anaconda Lower Works	1888	1902.
Washoe	1902	Active, 1913.
Boston & Montana	1892	Do.
Boston & Montana, enlarged	1900	Do.
Boston & Montana, rebuilt	1913	Do.
Pittsmont (East Butte Copper Mining Co.)	1904	Do.

The following table gives the output of metal produced in Silver Bow County for the years 1882 to 1913, inclusive, It was prepared

[1] Winchell, A. N., Mining districts of the Dillon quadrangle, Montana, and adjacent areas: U. S. Geol. Survey Bull. 574, pp. 90–96, 165–168, 1914.

[2] Pamphlet published by Am. Inst. Min. Eng. Committee, Butte meeting, August, 1913.

by Emmons [1] from many sources, including company records, reports on the mineral resources of the United States Geological Survey, and reports on the production of precious metals by the Director of the Mint. The figures given for mine production between 1904 and 1913 were prepared in one of the western offices of the United States Geological Survey.

Production of gold, silver, copper, lead, and zinc, and total gross value of output of Silver Bow County, Mont., 1882 to 1913.

Year.	Quantity.	Gold.[a]	Silver.[a]	Copper.[b]	Lead.[a]	Zinc (spelter).	Total value.[c]
	Short tons.	*Value.*	*Fine ounces.*	*Short tons.*	*Short tons.*	*Short tons.*	
1882		$250,005	2,699,296	4,529			$5,057,334
1883		301,003	3,480,547	12,332			8,234,027
1884		450,150	4,481,180	21,547			11,026,357
1885		286,057	5,180,331	33,899			13,151,180
1886		645,437	5,924,315	28,806			12,905,399
1887		995,865	6,958,981	39,350			18,676,221
1888		916,177	8,275,956	48,949			25,142,435
1889		654,305	6,560,038	49,111			20,080,771
1890		531,370	7,500,000	56,490	25		26,033,640
1891		607,649	7,785,090	56,032	125		22,867,743
1892		748,796	8,311,130	81,603	2		26,911,549
1893		698,873	6,668,730	77,605			22,663,068
1894		760,062	7,561,124	91,536	25		22,917,139
1895		856,496	10,051,760	95,086			27,738,560
1896		1,236,505	11,120,732	110,959			32,765,766
1897		1,120,372	10,710,815	115,144			35,181,438
1898		1,144,061	8,996,555	103,087			32,017,500
1899		1,282,438	9,855,831	112,563	10		45,693,529
1900		1,127,689	9,454,279	135,369	106		51,941,258
1901		947,803	10,136,892	114,935	60		45,424,267
1902		951,958	10,106,884	144,452	51		41,559,049
1903		1,008,785	9,811,544	136,278	105		43,655,970
1904	4,102,604	971,046	10,530,582	145,017			44,187,679
1905	4,419,300	1,266,175	11,191,016	152,154	570	780	55,643,230
1906	5,019,234	1,250,563	10,715,721	144,800	448	3,290	64,810,013
1907	3,735,346	710,442	7,516,659	109,418	112	122	49,464,959
1908	3,858,058	661,619	8,500,729	125,075	299	820	38,289,087
1909	5,000,062	815,368	10,609,328	155,662	100	4,650	47,315,005
1910	4,709,429	765,155	10,400,840	142,132	175	15,810	44,206,144
1911	4,569,942	731,905	10,258,122	136,136	509	21,867	42,741,229
1912	5,243,935	794,643	11,352,106	154,111	648	13,396	60,539,927
1913	5,612,530	779,744	12,211,725	142,841	2,271	44,265	57,593,753
Total		26,268,516	275,118,838	3,077,098	5,650	90,770	1,096,435,226

[a] Figures from reports of Director of the Mint, 1882–1903, and from Mineral Resources, 1904–1913.
[b] Figures from U. S. Geol. Survey Mineral Resources.
[c] Average commercial prices used for each metal to make total for each calendar year.

This table of metal output for Silver Bow County is practically that for the Summit Valley or Butte district and shows the region to have produced from 1882 to 1913, inclusive, gold, silver, copper, lead, and zinc valued in all at $1,096,435,226, which includes $26,268,516 for gold, $191,765,310 for silver, $865,794,271 for copper, $513,544 for lead, and $12,093,585 for zinc.

In 1913 the Ophir mine and mill of the Butte Central Copper Co. were operated from February 20 to June 10, closing because the ores were too low grade for profitable treatment. At the close of 1913, the Butte-Alex Scott mine was producing 150 tons of ore daily. It is developed by a shaft 2,065 feet deep. The Tropic mine, situated near the Butte-Duluth and owned by the Anaconda Copper Co., has developed a large body of low-grade oxidized ore on the 700 level. The Davis-Daly mine produced an average of about 250 tons of copper ore per day during 1913.

[1] Weed, W. H., Geology and ore deposits of the Butte district, Montana: U. S. Geol. Survey Prof. Paper 74, pp. 22–23, 1912.

The Anaconda Copper Mining Co.[1] performed 35.3 miles of development work, and the shafts of the different properties were sunk during 1913 to additional depths aggregating 3,841 feet.

Several causes combined tended to lessen the output of refined copper made by your company during the year 1913, as compared with that of the year 1912. In the first place, the severity of the weather during the months of January and February, 1913, made it impossible to furnish the reduction works with a normal supply of ore, and in the month of October it was found necessary to cease operations at the smelter at Anaconda for a period of 11 days, in order to clean the main flues and make necessary repairs * * *. In addition to this, a large amount of ore resulting from sill floor development work in low-grade sections of the mines was treated at the reduction works. The cost per pound of copper produced during the year 1913 was higher, due to the shutdown which has been mentioned, and also owing to the fact that the grade of ore treated was somewhat lower than that of the year previous. * * * There was a marked improvement on the 2,400-foot level of the Anaconda mine. On the 3,000-foot level of the Original mine a large vein carrying a good grade of ore was disclosed by the crosscut. This level in the Original mine is at the greatest depth yet attained in the Butte district at which ore has been developed, with the exception of the High Ore mine. Two compartments of the High Ore shaft were sunk to the 3,400-foot level during the year. Stations were cut, and the other compartments of the shaft are being upraised to the 2,800-foot level. As soon as this work has been completed, development work will be pushed on the 3,000, 3,200, and 3,400 foot levels. * * * On December 31, 1913, the following main hoisting engines were being operated by compressed air: Diamond, High Ore, Original, Tramway, West Gray Rock, Mountain View, Pennsylvania, Leonard, West Colusa, and Berkeley. The last two engines were installed during the year 1913. In addition to the compressed-air auxiliary engines which have been in operation at the Green Mountain and Diamond mines, five auxiliary engines were put in place and operated during the year at the Mountain View, Modoc, West Colusa, Leonard, and Tramway shafts. * * * Electric haulage, as practiced in the Butte mines, has demonstrated the great economies to be effected by it over any other system of tramming, and there are at present at the mines of your company 75 electric locomotives in operation underground and 25 on surface. Preparations are being made to use electric haulage at all of the mines. * * * The mines of the company produced during the year 4,644,201.24 tons of ore and 7,243.62 tons of precipitates, or a total of 4,651,444.86 tons. The reduction works treated for all companies during the year 4,016,689.16 tons of ore and other cupriferous material at Anaconda, and 1,170,150.43 tons of ore and other cupriferous material at Great Falls. Of this 4,566,450.85 tons of ore from company mines, 619,864.03 tons of ore were purchased from or treated for other companies, and 524.71 tons of precipitates and cleanings from the Old Works were treated, from which there were produced 205,730,594 pounds of fine copper, 9,026,690.13 ounces of silver, and 59,934.869 ounces of gold at Anaconda; and 64,571,050 pounds of fine copper, 1,294,606.08 ounces of silver, and 10,963.565 ounces of gold at Great Falls, or a total production of 270,301,644 pounds of fine copper, 10,321,296.21 ounces of silver, and 70,898.434 ounces of gold; of which amount 241,983,323 pounds of fine copper, 8,719,132.54 ounces of silver, and 64,898.434 ounces of gold were produced from mines of your company.

The East Butte Copper Co., operating the Pittsmont smelter, increased its copper output in 1913. Mining was confined to the sixth, eighth, and tenth levels. The main shaft was deepened 300 feet to a depth of 1,600 feet. Preparations are being made for the enlargement of the smelter and concentrator in 1914. According to the annual report of the company[2]—

there were mined * * * 105,071 tons of ore, averaging 5.16 per cent in copper content, at a cost, including all mine development for the year, of $5.08 per ton. Of this amount 71,569 tons were first class and averaged 6.31 per cent in copper content and 33,502 tons were second class and averaged 2.7 per cent in copper content. The proportion of first class was therefore 68 per cent and the proportion of second class was 32 per cent of the total amount mined. * * * The smelter treated a total of 186,815 tons of ore, producing 14,401,108 pounds of copper, 506,897 ounces of silver, and 8,803 ounces of gold yielding a gross revenue of $2,471,551.74. * * * Among the surface improvements during the year the most important consist of a complete remodeling of the concentrating plant. When complete the coarse crushing

[1] Ann. Rept. for year ending Dec. 31, 1913.
[2] East Butte Copper Co. Ann. Rept. for year ending Dec. 31, 1913.

of the ores will be done at the sample mill. The ore will be redelivered at this point to railroad cars and transferred to the concentrator. Here a storage of five to seven days' mill run has been provided to accommodate for fluctuations in ore supply. The entire screening and sizing system has been remodeled. The old Hartz jigs have been replaced by Hancock jigs, and a battery of 32 slime tables with necessary settling tanks have been provided.

The North Butte mines[1] yielded 454,984 tons of dry ore and 45 dry tons of copper precipitates, of which 121,773 tons were first-class ore and 333,211 tons second-class ore. This ore produced 28,318,321 pounds of fine copper, 1,602,163.67 ounces of silver, and 1,567.11 ounces of gold. The company has been engaged in sinking a 3-compartment shaft on the Granite Mountain claim and intends to equip the works with the largest electric hoisting plant in this county.

From the Tuolumne mine[2] 34,276 dry tons of ore were marketed, yielding net 1,880,514 pounds of copper, 77,571.76 ounces of silver, and 140.40 ounces of gold.

The average copper contents of the ores for the year were 3.84 per cent copper; 3.2 [ounces] silver, and 0.0058 [ounce] gold. The value of the ores treated after deducting smelting and freight charges was $200,217.77. * * * During the year 1913, the 3-compartment shaft has been sunk to the 2,400 foot station from a point 80 feet below the 2,000 foot station. Stations have been cut on the 2,200 foot level and the 2,400 foot level, and crosscuts run to the vein.

Production of the Tuolumne mine for the years 1909–1913, inclusive.

Year.	Quantity of ore.			Copper.	Silver.	Average content.	
	First class.	Second class.	Third class.			Copper.	Silver.
	Dry tons.	*Dry tons.*	*Dry tons.*	*Pounds.*	*Ounces.*	*Pounds per ton.*	*Ounces per ton.*
1909	1,713.9	1,334.7	3,048.6	475,439	10,728.05	7.8	3.52
1910	33,699.6	1,070.1	34,769.7	6,545,241	117,367.9	9.41	3.38
1911	24,935.4	4,905.7	29,841.1	4,261,705	96,373.2	7.16	3.24
1912	14,011.4	32,671.6	46,683	4,716,047	131,867.4	5.05	2.83
1913	930	33,346.5	34,276.5	2,633,651	109,705.32	3.84	3.2

* * * The Tuolumne Lode is developed by a 3-compartment shaft 2,395 feet deep, with stations, crosscuts, levels, and drifts at 200-foot intervals from the 400 to the 2,400-foot level, and with an 80-foot sump. The present equipment is capable of successfully and economically handling all material mined to a depth of 3,500 feet. The geological formation within which the Tuolumne is situated consists of the typical Butte granite quartz monzonite. The principal vein traversing the Tuolumne is the celebrated Jessie vein. This vein has a general course of N. 46° W., and in the lower levels dips from 78 to 86° south. This vein varies in width from 5 to 40 feet, and is a typical northwest fault fissure. A characteristic of this vein is the occurrence of large lenticular bodies of extraordinarily high grade ore, followed by barren stretches of lower grade pyritic ore. Upon the strike of this vein the Tuolumne Co. has 580 linear feet, and upon all the levels below the 600 [level] this vein has been drifted upon to the east end line of the Tuolumne property. Within this vein, in addition to the major ore shoots, there occur numerous minor ore bodies of considerable size which have had their origin through the movements due to the frequent faulting within this vein, or to other intersecting faults.

The Corbin Copper Co., owning mining property and a new concentration mill at Glenbeg in the Colorado district of Jefferson County, entered the Butte district in 1913, purchasing the Gambrinus, Walsh, and Belcher claims[3] west of the Gagnon mine.

[1] North Butte Mining Co. Ann. Rept. for year ending Dec. 31, 1913.
[2] Tuolumne Copper Co. Ann. Rept. for year ending Dec. 31, 1913.
[3] Corbin Copper Co. Ann. Rept. for year ending Dec. 31, 1913.

The shaft was sunk 300 feet during the year through the regular Butte granite or monzonite. * * * In the north crosscut one of the Syndicate veins has been encountered 180 feet from the shaft. This veins shows lead, zinc, and copper and is an exceptionally good showing for this depth. The vein material is very mineralized, mixed with granite and quartz, which is 5 feet wide. Both foot and hanging walls are well defined. * * * The Gambrinus vein can be traced for 900 feet on the surface of this company's ground into the West Gagnon property.

Published descriptions [1] of the Butte-Duluth and Bullwhacker copper leaching plants, which were erected at Butte in 1913, are of interest.

The Butte-Duluth plant is 100-ton and the Bullwhacker 125-ton. In the former the ore is crushed by gyratory and Symonds disk crushers only through a ½-inch screen; in the latter it is reduced by rolls until it passes 16 mesh. The ½-inch ore is dumped into V-shaped leaching vats, provided with a filter bottom of boards bored with ⅝-inch holes. After leaching with acid, the vats are discharged through doors in the bottom. The solution is drawn from the vats, allowed to settle, elevated to lead-lined tanks, where it is heated to 60° C., and thence to the electrolytic cells. Each of these is 30 by 30 inches and 8 feet long, lined with hard lead, and provided with 20 anodes of hard lead, weighing 20 pounds per square foot. The cathodes are ordinary starting sheets of copper. The current density used is 12 to 13 amperes per square foot, and the cathode assay 99.96 per cent copper, according to Peterson.[2] The present cost is estimated by him as 14 cents per pound of copper, but he thinks this can be considerably reduced, as the sulphuric acid required now costs $27 per ton or 4¾ cents per pound of copper produced. If locally manufactured on a large scale, the sulphuric acid should not cost over 1½ cents per pound of copper. The percentage of extraction on the ½-inch ore was so low that it was necessary to abandon that method and for a little over two months now the following process is being successfully carried on.

The company is building at the present time a 1,000-ton dry-crushing plant to reduce the ore to 10 mesh. This consists of swing-jaw crusher, intermediate gyratory crusher, Symonds disk crusher, rolls, and impact screens. The dry ore is fed to a mixer with approximately four times its weight of 8 to 10 per cent sulphuric acid which discharges to a Dorr classifier, which is the first of a series of 6 arranged in such a manner that the sand will discharge from one into the next. Various times of contact with the acid in the first four Dorr classifiers were tried out and it was found that approximately 40 minutes gave an extraction between 85 and 90 per cent. The last two classifiers, Nos. 5 and 6, in the series, are used for washing. The overflow from No. 5 is used to make up for the loss of acid in the strong acid solution.

The overflow from No. 1 classifier carries off approximately about 13 per cent of the total weight of ore as slime. This, as well as the overflows from classifiers 2, 3, and 4 are run to the acid leaching tanks in the bottom of which is a layer of crushed ore to act as a filter. The underflow from these filters passes to the electrolytic cells and on to the strong acid storage tanks where the solution is brought up. This method of running the slime to the acid leaching tanks is only temporary, as later on it is intended to recover the dissolved copper content by passing this pulp through a series of Dorr continuous thickeners operated so as to give countercurrent washing.

The second water wash, which is applied to the last classifier, goes to scrap-iron precipitation. The sand discharged from the classifiers approximates 18 to 20 per cent moisture. No. 1 classifier in the series is a machine 30 feet long and 4 feet 6 inches wide. The rest of the classifiers are of standard duplex size, 15 feet long by 4 feet 6 inches wide. These machines are built with wooden boxes and all moving parts that come in contact with the acid [are] also built of wood (hard maple). The wear of the wooden teeth is surprisingly small, but experimentation has shown that plate-glass teeth are the proper thing to use here, and [they] will be installed in any future classifiers built for this purpose. This series of six classifiers is operating at the present time and has a capacity of approximately 200 to 220 tons per 24 hours.

The Dorr Cyanide Machinery Co. is building another series of 5 machines, each 30 feet long by 8 feet wide, which should have a capacity of 400 to 500 tons of ore per day. At the present time strong acid solution is being added with the ore to No. 1 classifier, but later on this practice will be altered and the overflow from No. 5 Dorr classifier will be mixed with the dry ore, the advantage of this being that the strong solutions can be kept from coming in contact with the slime, the weak acid solution not taking iron and aluminum into solution so readily as the strong. All solutions in the plant are kept at approximately 55° C. The cost of this in the northern winter climate is likely to form a considerable item of the total working cost.

[1] Read, Thomas T., Min. and Sci. Press, Jan. 3, p. 56, 1914.
[2] Peterson, P. E., Min. Eng. World, Sept. 6 (p. 423) and Oct. 4 (p. 585), 1913.

At the Bullwhacker plant, which is nearby, the ore, crushed to 16 mesh, is agitated with 10 per cent H_2SO_4 solution, 2 tons of solution to 1 of ore, in a Hendryx agitator. This agitator is to be replaced by Derr classifiers when the plant is enlarged. The effluent solution, containing as much as 4 to 5 per cent copper, is decanted from settling tanks and sent to electrolytic cells which differ from those previously described in being circular, 9 feet in diameter and 5 feet deep, holding 24 cathodes. About half of the copper content of the solution is deposited electrolytically, and it then goes back to be used for further leaching. The cost of production of copper is here also about 14 cents per pound.

The Butte & Superior Copper Co.[1] in 1913 produced 104,174 tons of zinc concentrate, in which the gross content of zinc was 102,102,868 pounds averaging 49.005 per cent of zinc and 24.19 ounces of silver per ton; there were also produced 2,269 tons of lead concentrate averaging 29.41 per cent of lead, 19.72 per cent of zinc, and 43.28 ounces of silver per ton.

During the year no attempt was made to block out an increase of ore reserves, development work being confined strictly to that required in connection with current mining operations and principally to the workings above the 1,300-foot level. Some additional tonnage was developed above the 900-foot level, but the total tonnage above this level is not great and will be worked out completely before the end of 1914. Between the 900 and the 1,300 foot levels considerable quantities of new ore were developed, but as most of the tonnage mined during the year came from these levels, such development did not keep pace with ore extraction, and, in terms of ore actually blocked out and measurable, the portion of the mine above the 1,300-foot level suffered depletion of blocked ore reserves during the year to the extent of about 150,000 tons; whereas the total ore mined for the year amounted to approximately 300,000 tons. * * * Technical calculations of ore completely blocked out at the end of the year showed about 1,050,000 tons, as compared to 1,200,000 tons as stated in the last annual report as of December 31, 1912. * * * The average grade of the ore reserves actually blocked out and measurable remains approximately as stated in the report of 1912, at slightly over 21 per cent zinc, accompanied by about 7 ounces of silver per ton. The ore also contains very small quantities of gold, copper, and lead, which nevertheless add quite substantially to the value of metal products. * * * The total ore mined for the year was 293,706 tons at an average cost for the year of $3.12 per ton. This cost includes all development work incurred in direct connection with mining and in blocking out additional ore reserves to replace those currently extracted, but it does not include the expense of work intended to develop outlying claims. * * * Up until near the end of the year the mill was limited to some extent in its tonnage by the inability of the mine to produce sufficient ore, but when running full time it has a continuous and economical capacity of not less than 1,200 tons per day. * * * During the first quarter of the year 1913, when the first section of the mill had not yet been completely remodeled and brought up to a fair state of operating efficiency, the recoveries were 73.47 per cent. During the second quarter these were increased to 88.33 per cent. During the third quarter the recoveries were 89.49 per cent, and for the fourth quarter 90.15 per cent, making the average recoveries for the year 1913 86.43 per cent. * * * The average cost of milling for the first half of the year, when only one section was in operation, was approximately $3.25 per ton. During the second quarter when two sections were in operation for two months of the period only and then not at full capacity, the milling cost was $2.55 per ton. For the last quarter of the year this cost was reduced to $2.18 per ton and in the month of December, when conditions had been further improved, the cost was $2.05 per ton, as compared with an average of $2.69 per ton for the year, and it is believed that in the future the cost will not average in excess of $2 per ton under ordinary operating conditions.

Average assay per ton of crude ore milled and concentrates produced from Butte-Superior ores in 1913.

Kind of material.	Tonnage.	Average assay.				
		Gold.	Silver.	Copper.	Lead.	Zinc.
		Per ton.	*Per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Crude ore milled	296,940	0.021	10.59	0.23	1.169	19.89
Zinc concentrate	104,174	.050	24.19	.47	2.080	49.00
Lead concentrate	2,269	.830	43.28	.31	39.410	19.72

[1] Second Ann. Rept. for year ending Dec. 31, 1913.

The total gross value of lead and zinc concentrates as sold under our smelting contracts was $3,526,660.89. * * * The average total cost of mining and milling for the year, including mine development, mill maintenance, and all fixed and general charges, was $5.70 per ton. On this basis the average cost per pound of zinc, based on the total zinc contained in concentrates, was 4.45 cents, this cost including, of course, all smelting and transportation charges and having applied as a credit to it the net values derived from lead concentrates and all metals other than zinc which were produced at a profit. During the last quarter of the year the total cost of mining and milling was $5.24, and on this basis the average cost per pound of zinc contained in concentrates was 4.16 cents after applying credits for the value of other metals as previously stated. On a basis, therefore, of $3 for mining and $2 for milling, or a total cost of $5 per ton for both operations, which it is believed will be closely approximated for the coming year, the average cost of producing zinc, based on the total contents of zinc concentrates, will be approximately 4 cents per pound.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY ON METAL MINING AND MINERALS IN MONTANA.

BARRELL, JOSEPH, Geology of the Marysville mining district, Montana: Prof. Paper 57, 178 pp., 1907.

CALKINS, F. C., and MACDONALD, D. F., A geologic reconnaissance in northern Idaho and northwestern Montana: Bull 384, 112 pp., 1909.

——— and JONES, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: Bull. 540, pp. 167–211, 1914.

EMMONS, W. H., Gold deposits of the Little Rocky Mountains, Montana: Bull. 340, pp. 96–116, 1908.

——— and CALKINS, F. C., Geology and ore deposits of the Philipsburg quadrangle, Montana: Prof. Paper 78, 272 pp., 1913.

HILL, J. M., The mining districts of the western United States, with geologic introduction by Waldemar Lindgren: Bull. 507, 309 pp., 1912.

IDDINGS, J. P., and WEED, W. H., Geol. Atlas, Livingston folio (No. 1), 1894.

KNOPF, ADOLPH, Ore deposits of the Helena mining region: Bull. 527, 143 pp., 1913.

LINDGREN, WALDEMAR, A geological reconnaissance across the Bitterroot Range and Clearwater Mountains in Montana and Idaho: Prof. Paper 27, 123 pp., 1904.

PEALE, A. C., The Paleozoic section in the vicinity of Three Forks, Mont., with petrographic notes by G. P. Merrill: Bull. 110, 56 pp., 1893.

——— Geol. Atlas, Three Forks folio (No. 24), 1896.

PEPPERBERG, L. J., Notes on the mineral deposits of the Bearpaw Mountains, Montana: Bull. 430, pp. 135–146, 1910.

PIRSSON, L. V., Petrography and geology of the igneous rocks of the Highwood Mountains, Montana: Bull. 237, 208 pp., 1905.

SANFORD, SAMUEL, and STONE, R. W., Useful minerals of the United States: Bull. 585, pp. 108–113, 1914.

SCHRADER, F. C., Gold-bearing ground moraine in northwestern Montana: Bull. 470, pp. 62–74, 1911.

STONE, R. W., Geologic relation of ore deposits in the Elkhorn Mountains, Montana: Bull. 470, pp. 75–98, 1911.

WEED, W. H., Geology of the Little Belt Mountains, Montana, with notes on the mineral deposits of the Neihart, Barker, Yogo, and other districts: Twentieth Ann. Rept., pt. 3, 1900.

——— Gold mines of the Marysville district, Montana: Bull. 213, pp. 88–89, 1903.

——— Geology and ore deposits of the Butte district, Montana: Prof. Paper 74, 262 pp., 1912.

——— Mineral vein formation at Boulder Hot Springs, Mont.: Twenty-first Ann. Rept., pt. 2, pp. 227–255, 1900.

——— and PIRSSON, L. V., Geology and mineral resources of Judith Mountains of Montana: Eighteenth Ann. Rept., pt. 3, pp. 437–616, 1897.

——— and PIRSSON, L. V., Geology of the Castle Mountain mining district, Montana: Bull. 139, 164 pp., 1896.

——— and BARRELL, JOSEPH, Geology and ore deposits of the Elkhorn mining district, Jefferson County, Mont.: Twenty-second Ann. Rept., pt. 2, 1902.

——— Geol. Atlas, Fort Benton folio (No. 55), 1899.

——— Geol. Atlas, Little Belt Mountains folio (No. 56), 1899.

WINCHELL, ALEXANDER N., Mining districts of the Dillon quadrangle, Montana, and adjacent areas: Bull. 574, 191 pp., 1914.

ZINC.

(GENERAL REPORT.

By C. E. Siebenthal.

INTRODUCTION.

An estimate of the production of primary [1] spelter in 1913 was given out in the form of a press bulletin on January 2, 1914. This was based on reports from every smelter and gave the actual production for the first 11 months with an estimate for the remainder of the year. The total thus obtained was less than one-third of 1 per cent below the final figures which were given in the advance statement of spelter production and consumption published February 21, 1914. This very close agreement indicates the great care used by the smelters in making up their new year estimates for the Survey and shows that, so far as the general production is concerned, the Survey's New Year figures, for all practical purposes, may be accepted as final.

In July, 1911, a mid-year census was taken of the production of spelter during the first six months of the year, and the results were given out in the form of a press bulletin. This plan has since been followed and has been so well approved by producers and others that it will hereafter be a feature of the Survey's zinc reports, as it was formerly, from 1892 to 1901, inclusive. The production by semiannual periods from 1911–1914 is given on a later page.

The present report includes the figures given out in the advance statement and contains in addition tables of imports and exports of spelter and of zinc ore, a comparison of mine and smelter returns, a list of zinc smelters, a brief review of the advance in metallurgy and ore dressing as applied to zinc ores, and finally, a summary of the domestic and foreign conditions of the zinc industry.

The statistics of production in this country have been compiled by the United States Geological Survey from confidential reports by each zinc smelting company in operation during 1913.

Statistics of the recovery of secondary zinc were collected from all the important secondary smelters and refiners. The statistics of domestic consumption are taken in part from the smelter returns and in part from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, and the tables for foreign production and consumption were compiled from the sources indicated.

[1] In Mineral Resources for 1906, p. 461, zinc derived from ore was called "primary" spelter to distinguish it from the secondary spelter recovered from such sources as drosses, skimmings, and old metal. The former has also been called "virgin" spelter, and the latter has been called "remelted," "reclaimed," and "dross" spelter. The distinctive origin is more plainly suggested by the terms "primary" spelter and "secondary" spelter, and they are used herein. The terms have no reference whatever to the qualities of the product. Where the word "spelter" is used without qualification, primary spelter will be understood.

STATE OF ZINC INDUSTRY IN 1913.

The production of primary smelter from domestic ores in 1913 was 337,252 short tons, valued at $37,772,224, based on the average St. Louis price, as compared with 323,907 tons, valued at $44,688,166, based on the average St. Louis price, in 1912—a gain of 13,345 tons, equal to 4.1 per cent in quantity, and a loss of $6,926,942, equal to 15.5 per cent in value.

The total production of spelter from both domestic and foreign ores in 1913 was the greatest in the history of the zinc-smelting industry of the United States, being 346,676 short tons, as against 338,806 tons in 1912, a gain of 7,870 tons, or 2.3 per cent. Along with this increase in production there was a large decrease in the apparent consumption, which was 45,002 tons less than the large consumption of 1912. This resulted in increasing the stocks at smelters to 40,659 tons, the largest stocks in the history of the zinc-smelting industry.

The imports of spelter were 6,100 tons, as compared with 11,115 tons in 1912, a little more than half. Of this quantity, 5,302 tons were imported in January, with the result that spelter dropped 1 cent a pound within a month. The large concealed stocks which had been laid in by consumers on the rising market in the latter part of 1912 now satisfied the demand for spelter, and stocks began to accumulate at the smelters, reaching at the close of the year the large figures given above.

The total production of spelter was equivalent to the output of 81,571 average retorts operating continuously through the year on 60 per cent zinc concentrates. The capacity available for ore of the plants active in 1913 was about 101,000 retorts at the beginning of the year. Many of them, of course, were used on low-grade ores, lessening their capacity. To these, 5,850 retorts were added during the year, of which 4,120 were in Illinois and 1,730 in Kansas. The total number of retorts at the close of 1913 was 111,458. Owing to the depressed price of spelter during the latter part of the year, many of them were idle, so that in December only 89,683 retorts were in operation. Nevertheless, the United States retained first place in the world's production of spelter, with 31.7 per cent of the total output, the same percentage as in 1912.

PRODUCTION.

ANNUAL PRODUCTION 1873–1913.

The production of spelter in the United States began in 1858 in an experimental way [1] and regular production began in 1860 at the Lehigh Zinc Works in the East and at the Matthiesson & Hegeler works in the West. Between 1864 and 1870 nine or ten other zinc smelters were established. Statistics of production are recorded for the years 1873 and 1875 and for the census year ending May 31, 1880. Annual statistics have been collected by the United States Geological Survey since 1882. The annual progress of the zinc-smelting industry since 1873 is shown in the following table:

[1] Ingalls, W. R., Lead and zinc in the United States, p. 314.

Annual production of spelter in the United States from domestic and foreign ores, 1873–1913, in short tons.

Year.	From foreign ore.	From domestic ore.	Total.	Year.	From foreign ore.	From domestic ore.	Total.
1873	.....	7,343	7,343	1897	.....	99,980	99,980
1875	.....	15,833	15,833	1898	.....	115,399	115,399
1880	.....	23,239	23,239	1899	.....	129,051	129,051
1882	.....	33,765	33,765	1900	.....	123,886	123,886
1883	.....	36,872	36,872	1901	.....	140,822	140,822
1884	.....	38,544	38,544	1902	.....	156,927	156,927
1885	.....	40,688	40,688	1903	.....	159,219	159,219
1886	.....	42,641	42,641	1904	.....	[a] 186,702	186,702
1887	.....	50,340	50,340	1905	.....	[a] 203,849	203,849
1888	.....	55,903	55,903	1906	25,076	199,694	224,770
1889	.....	58,860	58,860	1907	26,115	223,745	249,860
1890	.....	63,683	63,683	1908	19,675	190,749	210,424
1891	.....	80,873	80,873	1909	25,535	230,225	255,760
1892	.....	87,260	87,260	1910	16,705	252,479	269,184
1893	.....	78,832	78,832	1911	14,905	271,621	286,526
1894	.....	75,328	75,328	1912	14,899	323,907	338,806
1895	.....	89,686	89,686	1913	9,424	337,252	346,676
1896	.....	81,499	81,499				

[a] Including an unknown quantity smelted from foreign ore, small in 1904, but larger in 1905.

PRODUCTION BY STATES.

Production of primary spelter in the United States in 1906–1913, apportioned according to source of ore, in short tons.

Source.	Quantity.								Percentage of total in 1913.
	1906	1907	1908	1909	1910	1911	1912	1913	
Arizona	64	77	152	2,862	2,594	2,476	4,092	4,675	1.38
Arkansas	1,801	1,911	2,002	135	286	385	604	478	.14
California	.....	140	27	.....	.....	959	1,672	1,012	.30
Colorado	32,456	26,077	24,885	20,121	23,238	42,233	60,841	58,113	19.23
Idaho	573	3,508	581	901	3,454	3,180	6,800	10,190	3.02
Illinois	282	1,446	298	675	1,551	2,884	3,952	1,345	.40
Iowa	201	220	516	.....	40	.....	.....	.....	.....
Kansas	3,902	13,850	8,628	9,185	10,220	6,843	5,668	9,956	2.95
Kentucky	335	358	341	22	29	205	394	172	.05
Maine	.....	1	.....	.....	.....	.....	.....	.....	.....
Missouri	130,348	141,824	123,655	140,676	140,652	127,540	149,557	129,018	38.26
Montana	1,415	.....	900	4,725	12,408	22,115	14,196	35,604	10.56
Nevada	1,708	1,692	308	825	1,516	1,595	6,132	5,828	1.73
New Jersey	11,206	13,573	6,926	16,035	20,217	15,128	16,941	24,247	7.19
New Mexico	555	136	134	3,961	4,911	3,778	6,882	3,765	1.12
North Carolina	.....	.....	.....	.....	.....	.....	.....	152	.04
Oklahoma	.....	719	2,235	3,008	2,297	2,247	2,041	6,397	1.90
Tennessee	124	181	341	695	925	1,000	1,935	2,635	.78
Texas	8	16	.....	.....	.....	.....	245	303	.09
Utah	2,449	1,972	282	5,960	7,221	7,004	7,756	9,503	2.82
Virginia	1,143	771	910	58	1,168	228	62	116	.03
Washington	7	.....	.....	.....	.....	12	.....	.....	.....
Wisconsin	11,057	15,273	17,538	20,381	19,752	31,809	34,137	33,743	10.01
Total from domestic ores	199,694	223,745	190,749	230,225	252,479	271,621	323,907	337,252	100.00
Foreign:									
Canada	201	545	2,425	978	3,304	1,598	4,199	1,424	.....
Mexico	24,875	25,570	17,250	24,557	13,401	13,307	10,700	6,205	.....
Europe	.....	.....	.....	.....	.....	.....	.....	1,175	.....
Siberia	.....	.....	.....	.....	.....	.....	.....	620	.....
Total from foreign ores	25,076	26,115	19,675	25,535	16,705	14,905	14,899	9,424	.....
Grand total	224,770	249,860	210,424	255,760	269,184	286,526	338,806	346,676	.....

Two tabulations of the spelter production of the country for a period of years are given, one showing the locality from which the ores were derived, the other the locality in which they were smelted. Each method has its special interests and advantages, depending on whether the viewpoint be that of producer or consumer or that of resources.

The State totals as given are compiled entirely from confidential reports by each company engaged in smelting zinc ores in the United States in the year in question. Only primary spelter is here included the recovery of secondary spelter being given in a later table.

The foregoing table shows the sources of all ores and concentrates smelted for spelter in the United States in 1906–1913 and the quantity of spelter actually derived from the ores from these respective sources. Statistics of production according to source of ore were not collected prior to 1906.

The subjoined table shows the localities in which spelter was made

Production of spelter in the United States, 1873–1913, apportioned according to locality in which smelted, in short tons.

Year.	Illinois.	Kansas.	Missouri.	Oklahoma.	Eastern.	Southern.	Colorado.	Total.
1873								7,3
1875	6,678	600	4,650		3,305			a 15,8
1880 (census)	10,904	2,451	5,671		4,213			23,2
1882	18,201	7,366	2,500		5,698			33,7
1883	16,792	9,010	5,730		5,340			36,8
1884	17,594	7,859	5,230		7,861			38,5
1885	19,427	8,502	4,677		8,082			40,6
1886	21,077	8,932	5,870		6,762			42,6
1887	22,279	11,955	8,660		7,446			50,3
1888	22,445	10,432	13,465		9,561			55,9
1889	23,860	13,658	11,077		10,265			58,8
1890	26,243	15,199	13,127		9,114			63,6
1891	28,711	22,747	16,253		8,945	4,217		80,8
1892	b 31,383	24,715	16,667		9,582	4,913		87,2
1893	b 29,596	22,815	13,737		8,802	3,882		78,8
1894	b 28,972	25,588	11,992		7,400	1,376		75,3
1895	b 35,732	25,775	14,998		9,484	3,697		89,6
1896	b 36,173	20,759	14,001		8,139	2,427		81,4
1897	b 37,876	33,396	18,125		7,218	3,365		99,9
1898	b 47,103	40,132	19,533		8,631			115,3
1899	b 50,118	52,021	18,107		8,805			129,0
1900	b 38,750	62,136	14,741		8,259			123,8
1901	b 44,896	74,240	13,083		8,603			a 140,8
1902	b 47,096	86,564	11,087		12,180			a 156,9
1903	b 47,659	88,388	9,994		12,301		877	a 159,2
1904	47,740	107,048	12,150		14,893		4,871	a 186,7
1905	46,606	114,287	11,844		24,513		6,599	a 203,8
1906	47,939	129,564	11,077		29,930		6,260	224,7
1907	56,056	134,108	11,732	5,035	37,626		5,303	249,8
1908	50,244	99,298	10,201	14,864	32,738		3,079	210,4
1909	67,653	103,299	7,037	28,782	42,941		6,048	255,7
1910	73,038	105,697	5,571	34,760	43,606		6,512	269,1
1911	83,130	98,413	4,116	46,315	47,155		7,397	286,5
1912	88,397	101,104	7,085	76,925	56,252		9,043	338,8
1913	106,654	74,106	5,085	83,214	69,063		8,554	346,6

a Secondary spelter included: 600 tons in 1875; 2,716 tons in 1901; 2,675 tons in 1902; 3,302 tons in 19 3,300 tons in 1904; and 1,469 tons in 1905.

b Includes also the production of smelters in Indiana.

In view of the fact that this chapter can not be prepared for publ cation until late in the year, after the figures for the mid-year spelt statement are available, those figures have been utilized in the follo ing table, showing the production by States for six-month period though they include one six-month period in advance of the volun for the year:

Production of spelter in the United States, 1911–1914, by six-month periods, apportioned according to locality in which smelted, in short tons.

State.	Jan. 1 to June 30, 1911.	July 1 to Dec. 31, 1911.	Jan. 1 to June 30, 1912.	July 1 to Dec. 31, 1912.	Jan. 1 to June 30, 1913.	July 1 to Dec. 31, 1913.	Jan. 1 to June 30, 1914.
Illinois	41,255	41,875	44,224	44,173	53,524	53,130	62,062
Kansas	50,574	47,839	52,485	48,619	42,645	31,461	23,737
Oklahoma	19,997	26,318	36,010	40,915	43,253	39,961	45,443
All other States	28,370	30,298	33,777	38,603	40,791	41,911	43,816
Total	140,196	146,330	166,496	172,310	180,213	166,463	175,058

ZINC DUST.

Zinc dust is an impalpable powder which forms in the distillation of zinc when the zinc vapor is cooled too rapidly in the condensers or is diluted by too large a volume of other gas. It may constitute a large proportion of the metallic zinc obtained in electrothermic zinc smelting, but in ordinary retort smelting it usually amounts to between 3 and 10 per cent of the reduced zinc. The powder consists of metallic zinc with about 10 per cent zinc oxide, which probably exists as a film surrounding the metallic particles. These particles can not be made to coalesce by heating unless under great pressure, but must be again vaporized and condensed. Marketable zinc dust must not contain more than 10 per cent of zinc oxide and must pass through a screen of 100 meshes to the inch.

Zinc dust differs from metallic zinc in other physical properties, such as rapid oxidation, absorption of hydrogen, and generally greater chemical activity, resulting at times in spontaneous combustion or explosion. These properties are believed by Sang [1] to be due to conditions of stress resulting from rapid solidification, somewhat analogous to the condition in "Prince Rupert's drops."

These peculiar properties of zinc dust are the cause of many of its uses. Under the name of "indigo auxiliary" a paste of zinc dust is used to discharge locally the color in dyeing cotton goods, giving a white pattern on the background of dye. Zinc dust is used in fireworks and in making hydrogen for balloons. It is the basis of the various methods of dry galvanizing and is also used to furnish the zinc solution in electrozincing. One of the most important uses of zinc dust is as a substitute for zinc shavings in zinc precipitation in the cyanide treatment of gold and silver ores. For this purpose it is cheaper, quicker, more effective, and more convenient than zinc shavings, and the saving in cost is about one-third.

In American zinc-smelting practice heretofore the zinc dust has been charged back into the retorts, since under the former tariff if sold as dust it came into competition with foreign zinc dust admitted free of duty, whereas recovered as spelter it was protected by an import duty of 1½ cents per pound. Hence the small quantity of zinc dust heretofore used in this country has been imported from Belgium and Germany. The tariff act of 1909, as shown on a later page, established an import duty upon zinc dust of 1⅜ cents per pound, and the tariff act of 1913 changed this to 15 per centum ad valorem.

[1] Sang, Alfred, Old and new methods of galvanizing: Eng. Soc. Western Pennsylvania Proc., vol. 23, pp. 546–571, 1907.

A ruling of the Interstate Commerce Commission lists zinc dust and zinc flue dust as inflammable solids and directs that they must bear a yellow shipping label. Paragraph 1834 of the ruling covering this product reads as follows: "Packages must be tight and strong, and the interior packages must be so cushioned and secured that no rupture of either package can result from the ordinary shocks incident to transportation."

The United States Zinc Co. about the middle of 1910 began the preparation of zinc dust for market in the smelter at Pueblo, Colo. The market is mainly western, and the product is used for zinc-dust precipitation in cyaniding in South Dakota, Nevada, and elsewhere. The Grasselli Chemical Co., with zinc-smelting plants at Clarksburg, and Meadowbrook, W. Va., also has prepared zinc dust for market since 1911.

As there are but two producers the quantity and value of the output may not be disclosed, but it has been included in the zinc content of pigments in the following sections. For imports and prices, see under those headings in the later sections of this report.

ZINC PIGMENTS.

There are four white pigments which have zinc for a base, either in whole or in part—zinc oxide, leaded zinc oxide, zinc-lead oxide, and lithopone. All of these may be, and in the United States the first three usually are, made directly from ore.

Zinc oxide is the most important of these pigments. In European practice the oxide is made from spelter, though in France zinc oxide is made from ore in the electrothermic furnace invented by Côte and Pierron. In the United States the oxide is generally made from ore, but, in 1913, of the total production 5,700 tons were made from spelter, as compared with 5,959 tons in 1912. The production of zinc oxide in 1911–1913 may not be disclosed. In 1910 it was 59,333 short tons, as compared with 68,974 tons in 1909 and with 57,237 tons in 1908. The imports of zinc oxide for consumption in 1913 were 3,433 short tons, and the exports for the same period were 14,467 short tons.

Lead zinc oxide and zinc-lead oxide are produced from ore, both in some places at the same plant, the zinc-lead containing somewhat the larger percentage of lead. No zinc-lead oxide has been made since 1909. The production of leaded zinc pigment in 1911–1913 may not be disclosed, but in 1910 it was 7,111 short tons.

Lithopone is an intimate mixture by chemical precipitation of zinc sulphide and barium sulphate. It may be manufactured from spelter or zinc oxide, but in the United States it is now generally made from zinc skimmings, ashes, and scrap.

The zinc content of the various zinc pigments made in the United States in 1913 from ore, both domestic and foreign, was 67,699 short tons as compared with 62,876 tons in 1912, with 46,376 tons in 1911, with 50,660 tons in 1910, and with 54,139 tons in 1909. The quantities given for 1910 and later years include the zinc contents of the zinc dust produced during those years, which may not be disclosed separately, there being at present but two producers.

For further details of the production of zinc pigments the reader is referred to the chapter on mineral paints in Part II of Mineral Resources for 1913.

SECONDARY ZINC.

In the ordinary method of galvanizing, where the material to be coated is dipped into a bath of molten zinc, there is great loss of zinc in the form of semioxidized skimmings and of hard zinc drosses, caused by the alloy formed by the zinc with the iron of the tank and of the article being galvanized. In the larger galvanizing plants there are furnaces to refine these skimmings and drosses and to recover the spelter. There are also many small plants and some large ones which make a practice of buying galvanizers' skimmings and drosses and of recovering the spelter. A considerable quantity of old metal in the form of various alloys of zinc with copper and other metals is also worked over and brought up to the desired composition by the addition of new metal. At almost every brass foundry and machine shop in the country it is the custom to remelt and use brass filings, grindings, and scrap copper and brass, and it is manifestly impracticable to attempt to take full account of such material. Some of the zinc smelters running on ore find it advantageous to work in a quantity of secondary material, because the loss of zinc in distillation is practically a fixed quantity per charge, whether the charge be of low or high tenor. If secondary material high in zinc is mixed with low-grade ore, the loss per unit of metal recovered is thereby greatly lessened. In such cases they have made the proper returns to the United States Geological Survey, and account has been taken of such production in these reports prior to 1907 as dross or secondary spelter. As such spelter has been recovered by redistillation, it is practically indistinguishable in quality from spelter of ordinary grades made from ore. Several secondary smelters recovering zinc from drosses do so by redistillation, and these plants are included in the list of smelters on a later page. It has seemed advisable that the secondary spelter recovered by redistillation should be separated from that recovered by remelting, and it has accordingly been done in the table below.

Since 1907 statistics have been collected from the secondary smelters and refineries, for the years 1907 and 1908 by the writer and since by J. P. Dunlop, of the United States Geological Survey. In 1907 and 1908 reports were obtained from the larger plants only, but in 1909 the scope of the canvass was greatly enlarged, since which time the number of firms has been increased from about 40 to double that number, with a large increase in reported production. The following table gives the production of secondary zinc in the United States and a later table gives the production of secondary spelter in Europe:

Production of secondary zinc in 1908–1913, in short tons.

	1908	1909	1910	1911	1912	1913
Secondary spelter, redistilled	7,159	9,273	12,784	14,043	26,064	25,991
Secondary spelter, remelted	9,811	23,767	28,439	26,470	26,187	24,014
Recovered zinc in alloys, excluding old brass remelted	665	1,181	2,709	3,223	3,912	3,743
Recovered zinc in remelted brass	(a)	8,204	18,450	24,110	28,426	25,822
Secondary zinc recovered as metal	17,635	42,425	62,382	67,846	84,589	79,570
Secondary zinc recovered in pigment	1,091	2,154	2,646	3,036	4,619	3,705
Secondary zinc recovered in zinc chloride [b]	4,500	3,839	3,970	3,865	4,903	6,253
Total secondary zinc	23,226	48,418	68,998	74,747	94,111	89,528

[a] Statistics not collected.

[b] These figures include only the quantity of zinc in zinc chloride used in wood preservation treatment, and were furnished by courtesy of the Forest Service, Department of Agriculture.

Besides the decreased recovery of secondary zinc as spelter and in alloys as shown in this table, there was also decreased use of zinc skimmings and drosses in the manufacture of zinc pigments and lithopone, but a considerable increase in the quantity used in making zinc chloride. The zinc content of pigments and lithopone made from secondary zinc in 1913 was 3,705 tons, as compared with 4,619 tons in 1912, with 3,036 tons in 1911, and with 2,646 tons in 1910. The zinc content of zinc chloride manufactured from secondary zinc and used in the treatment of railroad ties, bridge timbers, etc., in 1913, is estimated at 6,253 tons, as against 4,903 tons in 1912, against 3,865 tons in 1911, and 3,970 tons in 1910.

The exports of zinc dross have almost completely stopped. They were only 28 tons in 1913, having been gradually reduced from 15,887 tons in 1906.

COMPARISON OF STATE TOTALS, BASED ON SMELTER AND ON MINE REPORTS.

The foregoing figures of the production of spelter by the respective States are compiled from reports from individual zinc smelters. For several years the production of the more valuable metals in the Western States has been also obtained by the United States Geological Survey from reports of individual mines, and since 1907 this has been extended over the whole country. In order to put the spelter production on the same basis as the mine figures, all the zinc which is manufactured into pigment directly from ore (excluding the quantity in zinc oxide manufactured from spelter, the inclusion of which would entail its duplication in the totals) is added to the production of metallic zinc. The zinc dust recovered during the year is also included here. The zinc recovered from secondary sources is excluded, since it has already been once reckoned as spelter. These facts must be borne in mind in comparing this table with the table showing the production of spelter. The State totals obtained by each method are compared in the following table:

Comparison of State totals of production of zinc, 1908–1913, based on smelter and mine reports, in short tons.

State.	1908				1909			
	Totals based on smelter reports.	Totals estimated from mine reports.	Differences.		Totals based on smelter reports.	Totals estimated from mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Arizona	152	339	.....	187	2,862	2,989	.....	127
Arkansas	2,002	605	1,397	.....	135	510	.....	375
California	27	0	27	.....	0	0	.....	.....
Colorado	29,907	15,065	14,842	.....	23,374	25,605	.....	2,231
Idaho	581	19	562	.....	901	676	225	.....
Illinois	298	1,717	.....	1,419	675	2,163	.....	1,488
Iowa	516	395	121	.....	0	35	.....	35
Kansas	8,628	14,119	.....	5,491	9,185	11,445	.....	2,260
Kentucky	341	0	341	.....	22	56	.....	34
Missouri	123,655	107,404	16,251	.....	140,811	130,162	10,649	.....
Montana	900	820	80	.....	4,725	4,680	45	.....
Nevada	398	558	.....	160	825	1,507	.....	682
New Jersey	47,643	67,165	.....	19,522	63,307	82,510	.....	19,203
New Mexico	616	1,788	.....	1,172	5,216	6,543	.....	1,327
Oklahoma	2,235	4,529	.....	2,294	3,008	7,806	.....	4,798
Tennessee	341	344	.....	3	695	596	99	.....
Texas	0	18	.....	18	0	0	.....	.....
Utah	282	730	.....	448	5,960	4,930	1,030	.....
Virginia	910	705	205	.....	58	58	.....	.....
Wisconsin	18,598	18,206	392	.....	21,414	23,152	.....	1,738
Total	238,030	234,526	.....	.....	283,173	305,423	.....	.....

Comparison of State totals of production of zinc, 1908–1913, based on smelter and mine reports, in short tons—Continued.

State.	1910				1911			
	Totals based on smelter reports.	Totals estimated from mine reports.	Differences.		Totals based on smelter reports.	Totals estimated from mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Arizona	2,594	2,742	.....	148	2,476	2,281	195	.....
Arkansas	286	994	.....	708	385	664	.....	279
California	0	0	.....	.....	959	1,404	.....	445
Colorado	25,883	38,545	.....	12,662	45,093	47,304	.....	2,211
Idaho	3,454	2,802	652	.....	3,180	4,170	.....	990
Illinois	1,551	3,549	.....	1,998	2,884	4,219	.....	1,335
Iowa	40	96	.....	56	.....	.....	.....	.....
Kansas	10,220	13,229	.....	3,009	6,843	10,272	.....	3,429
Kentucky	29	6	23	.....	205	158	47	.....
Missouri	140,653	128,589	12,064	.....	127,601	122,515	5,086	.....
Montana	12,417	15,819	.....	3,402	22,115	21,905	210	.....
Nevada	1,551	1,354	197	.....	1,618	1,774	.....	156
New Jersey	65,419	68,678	.....	3,259	53,413	77,445	.....	24,032
New Mexico	5,889	9,044	.....	3,155	3,813	5,119	.....	1,306
Oklahoma	2,297	6,394	.....	4,097	2,247	5,150	.....	2,903
Tennessee	925	966	.....	41	1,000	1,117	.....	117
Utah	7,288	8,184	.....	896	7,512	8,920	.....	1,408
Virginia	1,168	794	374	.....	314	[a] 1,113	.....	799
Washington	.....	.....	.....	.....	12	10	2	.....
Wisconsin	21,475	25,927	.....	4,452	33,359	29,720	3,639	.....
Total	303,139	327,712	.....	.....	315,029	345,260	.....	.....

State.	1912				1913			
	Totals based on smelter reports.	Totals estimated from mine reports.	Differences.		Totals based on smelter reports.	Totals estimated from mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Arizona	4,092	4,379	.....	287	4,675	4,714	.....	39
Arkansas	604	748	.....	144	478	478	.....	.....
California	1,672	2,173	.....	501	1,012	529	483	.....
Colorado	65,544	66,111	.....	567	63,914	59,673	4,241	.....
Idaho	6,824	6,953	.....	129	10,223	11,587	.....	1,364
Illinois	3,952	4,065	.....	113	1,345	2,236	.....	891
Kansas	5,668	10,633	.....	4,965	9,956	10,088	.....	132
Kentucky	394	491	.....	97	172	327	.....	155
Missouri	149,953	136,551	13,402	.....	129,662	124,963	4,699	.....
Montana	14,224	13,459	765	.....	35,805	44,337	.....	8,532
Nevada	6,271	6,661	.....	390	6,060	7,210	.....	1,150
New Hampshire	.....	.....	.....	.....	.....	15	.....	15
New Jersey	70,444	69,755	689	.....	84,690	84,122	568	.....
New Mexico	7,635	6,783	852	.....	4,545	8,262	.....	3,717
North Carolina	.....	142	.....	142	.....	10	.....	10
Oklahoma	2,041	5,769	.....	3,728	6,397	11,664	.....	5,267
Tennessee	1,935	2,191	.....	256	2,648	5,583	.....	2,935
Texas	245	119	126	.....	303	326	.....	23
Utah	8,220	8,534	.....	314	10,714	9,429	1,285	.....
Virginia	430	249	181	.....	392	2,719	.....	2,327
Wisconsin	36,635	33,050	3,585	.....	35,298	30,110	5,188	.....
Total	386,783	378,816	.....	.....	408,289	418,382	.....	.....

[a] Includes a small quantity of zinc from New York.

The smelter State totals represent actual recovery and are found by summing up the total production reported by all companies for each State, respectively, all pigments being recalculated back to equivalent metallic zinc on the basis of average analysis of product. In compiling the mine totals each producing property is requested to report actual tonnage of zinc ores and concentrates shipped, and from

this the zinc content is reckoned by assay value. From that zinc content 10 to 20 per cent, according to the character of the ore, is deducted for smelting losses, and the remainders thus obtained from all the producing properties in each State are combined to afford the totals for the respective States. Where the ore is concentrated at a custom mill, proper allowance is also made for the loss of metal in the process. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from each producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content and the theoretical recovery be correctly estimated. Theoretically, the State totals, as compiled from smelter reports and from mine reports, respectively, should in the long run agree closely. As a matter of fact, for any year they show considerable divergence. These discrepancies, giving rise to "smelter excess" or "mine excess," may be the result of one cause or of a combination of causes, among which are: Lag in the smelting of the ore, resulting in accumulation of ore stocks at the smelters; lag in the mining, owing to which the smelter depletes its ore stocks; error in calculating metallic content from assay and in estimating recovery; and error by smelters in exact distribution of spelter, by States, according to source.

Of these sources, the greater discrepancies arise from erroneous distribution by the smelters, in particular as among the States in the Joplin region and in the Upper Mississippi Valley region. Smelters using ore from the Joplin region are prone to credit it to Missouri because bought through their agents at Joplin. Similarly, in the upper Mississippi region the ore is likely to be credited to Wisconsin because bought through a Wisconsin buyer. In each region there are companies operating in more than one State but selling ore through a central office—a condition which likewise leads to error in distribution. Another cause for such error, particularly in the upper Mississippi region, is found in the electrostatic and electromagnetic separation plants, the ore from which is naturally credited to the State in which the plant is located.

The smelter reports give the exact annual production of zinc and serve as a check on the mine production, and they also give the form in which the zinc was recovered, whether as spelter or as pigment. The distribution among States by the smelter reports has value as a check on the mine State totals, and also because of the earlier publication, but for exact distribution of zinc production according to origin recourse must be had to the mine production reports.

MINE AND SMELTER TOTALS, 1913.

The smelter excess in California follows mine excesses in the two years preceding and is apparently due to lag in mining, as is the comparatively large smelter excess in Colorado, which follows mine excesses with a large total in the three preceding years. The mine excesses in Idaho, New Mexico, and Nevada, and the much larger one in Montana seem to be due to lag in smelting, which often happens in States when the production is rapidly increasing as the zinc output is in these States. The mine excess in Illinois, owing to ore from that State being credited to Wisconsin by the smelters, partly balances

a large smelter excess in Wisconsin, which must be due mostly to lag in smelting and must have resulted in depletion of Wisconsin ore stocks at the smelters. The mine excess in Oklahoma balances the smelter excess in Missouri and no doubt results from the crediting of Oklahoma ore to Missouri by the smelters. In Tennessee the mine excess is due to lag in smelting, owing to the rapidly increasing production in that State, which doubtless is also the correct explanation for the mine excess in Virginia. The smelter excess in Utah is due apparently to the depletion of Utah ore stocks at smelters.

RESOURCES.

UNITED STATES.

MINE PRODUCTION OF ZINC.

The following table shows, for each zinc-producing State, the total quantity of zinc ore produced, and the output of each kind of zinc ore. The column headed "All other ore" includes lead ore, copper ore, copper-lead ore, and dry or siliceous ore, no zinc of consequence being recovered from any of them except in Colorado. "Dry" ores produced in that State in 1913 contained 3,343 short tons of recoverable zinc. This, as in other States, was concentrated from parts of the ore from certain counties, however, and was not distributed through the whole of the "All other ore" credited to Colorado in 1913. The total crude ore yielding either gold, silver, copper, lead, or zinc is given for each zinc-producing State, so that a comparison may be made of the relative extent of deep mining operations for all five metals in these States, the quantity of crude ore raised being the best measure for this purpose. The table discloses the fact that Missouri made nearly one-fourth of the crude-ore production of the zinc-producing States, having an output of 12,300,100 short tons of crude ore, of which 8,049,300 tons was zinc bearing. Excluding iron ore, this was the largest production of metalliferous crude ore in the United States. Next in rank was Arizona, with 7,931,862 tons of crude ore; Michigan, owing to industrial conditions, dropped to third place, with 7,016,370 tons of crude copper ore.

The table gives also the quantity of recoverable zinc contained in the crude ores of each State and the quantity of zinc recovered from each kind of zinc ore. The percentage of recoverable zinc contained in the zinc ore and the zinc-lead ore of each State is also shown. The recoverable zinc content of crude zinc ore ranges from 42 per cent in Idaho down to 1.6 per cent in Missouri, the Western States having uniformly the higher percentage. The average recoverable zinc content of the zinc ore of the United States in 1913 was 2.8 per cent as against 2.6 per cent in 1912. Of the total mine production of zinc in 1913, a quantity corresponding to 77.7 per cent was derived from zinc ore, 21.5 per cent was derived from zinc-lead ore, and 0.8 per cent was recovered from all other ores. The figures of mine production of zinc are taken from the chapters on gold, silver, copper, lead, and zinc (mine production), in the various States, as indicated in the prefatory note.

Source of mine production of zinc in 1913, by States and kinds of ore, in short tons.

States.	Zinc ore.			Zinc-lead ore.			All other ore.		Total.	
	Crude ore.	Recoverable zinc content.	Per cent.	Crude ore.	Recoverable zinc content.	Per cent.	Crude ore.	Recoverable zinc content.	Crude ore.	Recoverable zinc content.
Arizona	14,554	2,510	17.2	29,700	2,175	7.3	7,887,608	29	7,931,862	4,714
Arkansas	13,000	478	3.7	.....	.....	.....	.....	.....	13,000	478
California	1,823	529	29.0	.....	.....	.....	2,494,135	.....	2,495,958	529
Colorado	141,295	33,153	23.5	203,367	23,177	11.4	2,390,204	3,343	2,734,866	59,673
Idaho	2,719	1,148	42.2	646,080	10,400	1.6	1,802,534	39	2,451,333	11,587
Illinois	119,200	2,236	1.9	.....	.....	.....	.....	.....	[a]119,200	2,236
Kansas	590,300	10,088	1.7	.....	.....	.....	.....	.....	590,300	10,088
Kentucky	[b]111,700	327	.....	.....	.....	.....	.....	.....	11,700	327
Missouri	8,049,300	124,963	1.6	.....	.....	.....	4,250,800	.....	12,300,100	124,963
Montana	3,840	376	9.8	307,615	43,961	14.3	5,648,663	.....	5,960,118	44,337
Nevada	10,208	3,174	31.1	16,749	4,036	24.1	5,340,254	.....	5,367,211	7,210
New Hampshire	400	15	3.8	.....	.....	.....	.....	.....	400	15
New Jersey	490,434	84,122	17.2	.....	.....	.....	.....	.....	490,434	84,122
New Mexico	40,439	6,859	17.0	8,735	1,403	16.1	2,168,486	.....	2,217,660	8,262
North Carolina	88	10	11.4	.....	.....	.....	11,186	.....	11,274	10
Oklahoma	581,100	11,664	2.0	.....	.....	.....	.....	.....	581,100	11,664
Tennessee	171,392	5,583	3.3	.....	.....	.....	652,253	.....	823,645	5,583
Texas	.....	.....	.....	3,172	326	10.3	21,902	.....	25,074	326
Utah	16,322	4,770	29.2	211,609	4,595	2.1	9,974,635	64	10,202,566	9,429
Virginia	30,034	2,719	9.0	.....	.....	.....	882	.....	30,916	2,719
Wisconsin	1,406,000	30,110	2.1	.....	.....	.....	.....	.....	1,406,000	30,110
Total	11,694,148	324,834	2.8	1,427,027	90,073	6.3	42,643,542	3,475	55,764,717	418,382
Per cent of total zinc derived from each kind of ore	77.7			21.5			0.8		100.0	

[a] This is exclusive of the fluorspar ore mined in southern Illinois from which a small percentage of lead is recovered in milling.
[b] Estimated.

BRIEF REVIEW OF ZINC-PRODUCING DISTRICTS.

For details of production in the various zinc-producing districts of the country the reader is referred to the mine reports for the individual States indicated in the prefatory note. This review is based on those reports or on notes furnished by the authors of the various reports. Only the general trend of development during the year will be here noticed in connection with the different districts.

EASTERN STATES.

New York produced some lead and zinc ore in 1911 for the first time in several years. The Northern Ore Co., operating the Edwards zinc and pyrite mine in St. Lawrence County, continued development work in the mine during 1913 and made extensive experiments to determine the best way to handle the ore for which a new mill was in course of construction. The mill was completed and had been in operation but a short time when it was destroyed by fire June 26, 1914. It is reported that the mill will be rebuilt. The mine is now developed by two shafts, and reaches a depth of 400 feet, with six levels, and with 436 feet of drifting at the 350-foot level, the ore body being reported as having a width of 4 to 7 feet of blende and pyrite.

The chief zinc-producing district in the eastern part of the United States is the famous Franklin Furnace region, of New Jersey, em-

bracing the great zinc deposits of Sterling Hill and Mine Hill. The former was mined continuously from about 1875 until 1900, and the latter is making near its maximum yield after over 60 years of active mining. The output of the Mine Hill and Sterling Hill mines made a large gain over 1912, being 490,434 tons of crude zinc ore, containing 84,122 tons of recoverable zinc, a gain of 30,849 tons of crude ore, and of 14,367 tons of recoverable zinc, the latter a gain of more than 20 per cent. The New Jersey Zinc Co. exported to Europe willemite concentrates from these mines to the aggregate of 17,713 short tons, with a value of $631,991, the remainder of the zinc production being made into spelter and zinc oxide.

Virginia made a splendid gain in zinc with a production of 2,719 tons, nearly 11 times the output of 1912. This increase came from the old and well-known mines of Wythe County, in part from the Austinville mine, which reaches a depth of 471 feet, and is developed by 10,000 feet of drifts. The ore in this mine consists of sulphides of zinc, lead, and iron, in a dolomitic gangue, and is oxidized to a depth of 235 feet. At the Little Wythe mine, hand-sorted oxidized zinc ore was gained incidental to mining iron ores. New prospects were developed at the Allah Cooper property, near Mineral, Louisa County; near Timberville, Rockingham County; and on an extension of the Bertha and Austinville belt in Wythe County.

North Carolina appeared as a zinc producer for the first time in 1912, with an output of 142 tons of zinc. This was obtained by the concentration and separation of zinc-lead sulphide ores from the Silver Hill mine of Davidson County. The mine was not operated in 1913, but there was a shipment of zinc concentrates, unsold from the previous year.

Tennessee made a large gain in zinc production as the result of operations at the new Mascot mill of the American Zinc Co. of Tennessee; at the Grasselli Chemical Co.'s mill; and at the old iron mines of the Embree Iron Co., at Embreeville. At the place last named oxidized zinc ore forms a deposit at the base of residual clays lying between "pinnacles" of limestone. The iron deposits occupied a similar position and possibly a considerable quantity of zinc ore was lost in exploiting the iron ore. The oxidized iron and zinc deposits of Virginia occur in similar relations. The new mill at Mascot started up in June, 1913. It has a daily capacity of 1,000 tons and is practically of the Joplin type, though with some refinements. A second shaft is being sunk and it was currently reported late in the year that plans for another mill of the same size as the foregoing were under consideration. The State output of zinc in 1913 was 5,583 tons, compared to 2,191 tons in 1912, an increase of 3,392 tons, or 150 per cent.

CENTRAL STATES.

The upper Mississippi Valley region, embracing adjacent productive areas of Wisconsin, Illinois, and Iowa, had a much smaller output of lead and zinc concentrates in 1913 than in 1912. The production of zinc concentrates was 106,931 tons containing 32,346 tons of recoverable zinc, a loss of 13 per cent in zinc output. Wisconsin, and the whole district in fact, dropped below Montana in rank as to zinc production. The Huff electrostatic separator at Platteville, destroyed by fire late in 1911, has not been rebuilt, and

the Wisconsin Zinc Co. has purchased the Campbell roaster at Cuba City. This plant and that operated by the Linden Zinc Co. use the Campbell patent roaster, which roasts the pyrite only slightly and leaves it in condition, after removal from the zinc blende, to be used for acid manufacture.

In the Kentucky-Illinois district the production of both lead and zinc concentrates fell off greatly, the output of recoverable zinc being just one-half and the output of lead being 56 per cent of the output of 1912. The low price of ore was largely responsible for the loss.

The Joplin region, embracing southwestern Missouri, southeastern Kansas, and northeastern Oklahoma, made a smaller output of zinc concentrates than in 1912 by about 3 per cent, the quantity being 291,110 tons in 1913 as compared with 299,421 tons the preceding year. The recoverable zinc content of the concentrates was 146,474 tons as compared with 152,465 tons in 1912, showing that the concentrates were somewhat lower in grade in 1913, owing probably to the increased production of the Miami district, the concentrates from which have a somewhat lower zinc content than those of the Joplin region in general.

The zinc concentrate sales of the district fell away sharply in the early part of the year, being but a little over 4,000 tons weekly during March. In April the sales increased and during the remainder of the year averaged about 5,500 tons weekly. The principal developments of the year were the extension of mining operations in the territory north and west of Joplin in Missouri, about Lawton and Badger, Kans., and north of Miami, Okla. At the latter place the runs of ore worked in previous years have had a northwesterly trend, but there has recently been developed a northeastern zone of ore-bearing ground reaching from the older mines to and beyond the Kansas State line. Practically all the territory along this zone is owned or under option or lease by mining companies and an extensive campaign of drilling is being carried on.

The production of zinc concentrates in northern Arkansas fell off over one-third. This was largely due to litigation which kept two of the largest mills closed during the greater part of the year and thus reduced the output of zinc-blende concentrates. On the other hand, the output of zinc carbonate ore was increased, owing mainly to activity in the shallow diggings at the Morning Star mine, and about Zinc. The recoverable zinc content of the ores produced was 478 tons, as compared with 748 tons in 1912.

WESTERN STATES.

The zinc production of Texas, though small, was considerably larger than in 1912, the quantity being 326 tons, as compared with 119 tons in the former year. This output was largely the product of the 75-ton mill which was operated a part of the year at the Bonanza mine in the Sierra Blanca district of El Paso County.

New Mexico made a gain of 22 per cent in zinc production with 8,262 tons, as against 6,783 tons in 1912. By far the larger part of this gain came from the Kelly district of Socorro County, but smaller quantities came from districts in Luna and Grant counties. The new 125-ton mill of the Ozark Mining & Smelting Co. operated steadily. It is equipped with a flotation plant. The Tribullion

Smelting & Development Co. sold the Kelly group of claims, and the Utter group of claims in the Pinos Altos district was purchased by the Empire Zinc Co.

The zinc production of Colorado fell off 6,438 tons, or about 10 per cent, the total being 59,673 tons, as compared with 66,111 tons in 1912. Lake County, including Leadville district, yielded 79 per cent of the zinc output of the State. Leadville carbonate shipments were 135,760 tons of 27.45 per cent zinc, as compared with 142,782 tons of 29.2 per cent zinc in 1912. Summit and Eagle counties were second and third in the production of zinc.

The recoverable zinc content of Montana ores in 1913 was 44,337 tons, an increase of 20,878 tons, or more than 150 per cent over the output in 1912. The great bulk of the output was a result of the operations of the Butte & Superior mill employing flotation concentration. This plant, from 296,940 tons treated, produced 104,174 tons of zinc concentrates averaging 49 per cent zinc, and 2,269 tons of lead concentrates averaging 39.4 per cent lead and 19.7 per cent zinc. When the Timbered Butte mill, also using flotation concentration, is completed the zinc production of Montana will be further augmented, so that ultimately the State is destined to be one of the two or three largest producers of zinc in the United States. By displacing Wisconsin in 1913, Montana now ranks fourth in zinc production.

Idaho made a gain of two-thirds in zinc production, with 11,587 tons as against 6,953 tons in 1912, an increase of 4,634 tons. Zinc concentrates obtained in milling the lead ores of the Coeur d'Alene district furnished most of the zinc, but some was derived from crude zinc ores. The zinc output was largely due to the operations of the Success, Morning, Green Hill-Cleveland, Interstate-Callahan, and Hercules mines. The introduction of flotation concentration for handling slimes and complex middlings was general and will increase the production of zinc. The old Frisco mine, near Gem, was unwatered and will add greatly to the future zinc output of the State.

The zinc production of Utah made a good gain from 8,534 tons in 1912 to 9,429 tons in 1913, or over 10 per cent. Beaver County produced nearly five times as much zinc as in 1912 and led all zinc districts in 1913. The Park City district was second in point of output, but fell off nearly 40 per cent from 1912. There were also important contributions from mines in the Ophir and Mount Nebo districts. Silicate and carbonate ores were produced by the Tintic district.

Arizona had a small increase in zinc output in 1913, which was 4,714 tons, an increase of 8 per cent over the 4,379 tons produced in 1912. Mohave County was the largest producer from mines at Union Pass and Chloride. Pima, Cochise, and Yavapai counties were also contributors to the zinc output of the State.

A fair gain in zinc production was made by Nevada with 7,210 tons, as against 6,661 tons in 1912, an increase of over 8 per cent. This zinc output came altogether from Clark and Lincoln counties. The Potosi mine at Good Springs, in the Yellow Pine district, was purchased late in the year by the Empire Zinc Co.

The zinc production of California in 1913 was but one-fourth that of 1912, being 529 tons, as compared with 2,173 tons in the former year. This was a result of reduced operations at the old Cerro

Gordo mine in Inyo County. In recent years this mine has produced considerable zinc carbonate ore, but it was formerly worked for silver-lead ores.

MEXICO.

Zinc deposits are found in the Mexican States of Tamaulipas, Nuevo Leon, San Luis Potosi, Coahuila, and Chihuahua, but most of the ore imported into the United States has come from the two last mentioned.

Statistics of imports of zinc ore from Mexico based upon "consular invoice" or "declaration" are available as far back as 1904, as given on a later page. According to these returns, the imports from Mexico, owing to the civil conflict in that country, were about half those in the preceding year, being 18,018 short tons, containing 6,377 tons of zinc, in 1913, as compared with 35,925 tons. containing 14,206 tons of zinc, in 1912.

CANADA.

The imports of zinc ore from Canada were 8,357 short tons in 1913, as compared with 8,015 tons in 1912.

The zinc ore produced in British Columbia now finds its way to the zinc smelters of the United States. In the past the output of these ores has not assumed great importance, but there is no doubt of their extended occurrence, and should commercial success attend the efforts at reduction the district would become an important zinc producer.

A strong endeavor is being made in the Dominion of Canada to develop a commercially successful method of reducing the complex zinc ores of the Kootenay district of British Columbia. The Dominion Government appropriated $50,000 for experimental work, a preliminary report upon which is summarized in a later section on metallurgy. The preliminary part of the work having been completed in the laboratories of McGill University at Montreal by Dr. Alfred Stansfield, experiments on a larger scale are now proceeding at the electrothermic zinc smelter at Nelson, British Colmbia.

Negotiations proceeded for a time during the early part of 1914 looking to the establishment of a trial furnace at Nelson embodying the electrothermic process of Woolsey McA. Johnson, but it is understood that the plans were finally abandoned.

AUSTRALIA.

The principal source of zinc in Australia is the silver-lead mines of Broken Hill, New South Wales. In the early days of Broken Hill mining the crude ore ran about 25 per cent each in lead and zinc and 25 ounces in silver, but by 1904 the average tenor had become reduced to 16 per cent each of lead and zinc with 11 ounces of silver to the ton. At present the average tenor is probably somewhat below those figures. In the effort to get rid of the zinc it was heaped up in enormous piles of zinc tailings and slimes from the concentrating plants, and lead concentrates with 20 per cent of zinc were smelted, lead slags averaging 16 per cent of zinc oxide with a maximum of 20 per cent having been run, according to Donald Clark.[1] Various leach-

[1] Clark, Donald, Australian mining and metallurgy, Melbourne, 1904, p. 372.

ing, electrolytic, and magnetic processes were successively tried and finally discarded for the flotation processes which have been in practical use since 1903. This method of concentration has the advantage that it can be applied to the current output of zinc tailings and slimes as well as to the accumulated stocks of those products.

The importance of flotation in that country is shown in the following table of the production of zinc concentrates at Broken Hill by flotation methods for the period 1911–1913, compiled from the annual reports of the department of mines of New South Wales. These concentrates are recovered from zinc middlings and tailings, both from the current product and from the stored accumulations of bygone years of milling operations. The minor quantities of lead concentrates recovered, as a table product from the zinc concentrates, are not included:

Production of zinc concentrates at Broken Hill, New South Wales, 1911–1913, in long tons.

Company.	Flotation process used.	1911		1912		1913	
		Tailings treated.	Concentrates.	Tailings treated.	Concentrates.	Tailings treated.	Concentrates.
Sulphide Corporation	Minerals Separation.	.....	78,822	.....	71,040	174,287	63,446
Broken Hill Proprietary	Potter-Delprat.	422,511	103,378	316,441	88,008	349,290	85,685
Zinc Corporation	Minerals Separation.	331,486	103,630	345,425	85,354	350,120	86,230
Minerals Separation	...do	105,297	33,058	.....	.....	.....	.....
Amalgamated Zinc (De Bavay's).	De Bavay.	542,015	159,133	538,086	147,013	498,289	140,098
British Broken Hill	Minerals Separation.	.....	24,679	.....	27,298	26,754	6,356
Junction North	.....	.....	.....	.....	.....	68,426	16,944
Total concentrates produced.	.....	.....	502,700	.....	418,713	.....	398,759
Average zinc content, per cent.	.....	.....	46.0	.....	47.2	.....	47.0

In 1903 the department of mines of New South Wales estimated the quantity of stored zinc tailings and other zincky residues at 5,687,400 long tons, containing an average of 18.6 per cent of zinc. In 1908 the stocks of zinc tailings were estimated by different authorities to amount to about 7,000,000 tons and to contain about 1,200,000 long tons of zinc, 350,000 tons of lead, and 40,000,000 ounces of silver. A correspondent of the Australian Mining Standard of April 6, 1910, puts the stock of tailings at 6,000,000 tons, the total capacity of the flotation plants when present plans are completed at about 31,000 tons weekly, and the current production of zinc tailings at 24,000 tons weekly. At this rate of excess of consumption over current production it would require about 16 years for the re-treatment-plants to absorb the accumulated tailings. This estimate is contingent upon the continuation in the future of the present rate of production of the mines.

The subjoined table compiled from the annual reports of the department of mines of New South Wales shows the quantity and zinc content of zinc concentrates exported from New South Wales from 1904 to 1913:

Exports of zinc (spelter and concentrates) from New South Wales, 1904–1913, in short tons.

Year.	Concentrates.	Zinc content.	Year.	Concentrates.	Zinc content.
1904	64,514	24,996	1909	418,775	161,300
1905	115,956	34,313	1910	524,862	207,085
1906	114,984	37,438	1911	578,343	213,321
1907	264,601	85,842	1912	582,980	217,520
1908	309,044	127,515	1913	567,482	206,247

The following extract from a recent authoritative volume [1] describing the flotation concentration of ores in Australia is interesting in this connection; and in view of the possibility of Australian zinc concentrates being exported to the United States during the war in Europe, it is repeated here:

There still remains untreated sufficient material to keep the present plants going until 1919, when the accumulated tailing should be exhausted. It is evident that the 1904 estimates of tonnage available were far short of the truth. It is not probable that there will be any further great increase in the annual production of zinc concentrate at Broken Hill. It seems more probable that the pinnacle of tonnage was reached in 1910, and that the production will decrease from now on until the accumulated tailing is finished. There should be no large drop in the total tonnage produced, because the Zinc Corporation, the Amalgamated Zinc, and the Broken Hill Proprietary have reserves of tailing that will last for several years to come. One large plant last year ceased operating, but its place was taken by two smaller ones. A steady, slow decrease in production may be expected, because most of these companies during their early struggles with the vagaries of the processes used their best material to make ends meet. They will probably make as much money out of their lower-grade material as they did out of the higher-grade material. When these immense piles are exhausted, which can be definitely predicted for 1919 or before, there will be a sudden drop in the zinc production of Broken Hill which should considerably disturb the world's zinc market. The present production of Broken Hill represents just about 20 per cent of the total world's production. It is a remarkable fact that this enormous increase in the production of a district which seven years ago produced practically no zinc has caused very little disturbance of the price. This was due to the fact that the high-grade Broken Hill zinc concentrate took the place of low-grade ores from many places in the world outside of the United States, and these latter low-grade mines simply ceased production because the low-grade material could not compete with the high-grade at the same metal price.

The material treated by these processes at Broken Hill is of comparatively high grade, averaging at present close to 18 per cent zinc, 6 per cent lead, and 7.5 ounces silver per long ton. In spite of these good assays the profits are not fabulous. After charging working cost, royalty to process owners, smelters' charges, and management, there is left, on an average, close to 12 shillings per ton treated. In the case of some of the companies this is further decreased by the prices paid to the mining companies for the tailing. The average price for all the tailing and slime sold by the mining companies to the treatment companies averages about 6 shillings per ton, leaving, on an average, not over 6 shillings per ton profit to the treatment companies when zinc is £23 per ton [5 cents per pound]. These are not the actual results of any one company, but are a fair average of the whole. Some of the companies increase this profit in favorable cases by anything up to 4 shillings per ton by the re-treatment of the flotation concentrate, by means of which re-treatment a good lead concentrate is taken out of the flotation concentrate. This lead concentrate represents about 50 per cent of the lead in the flotation concentrate. These figures mean that if the price of zinc dropped to £20 per ton the flotation plants would have to close down or else reduce the working cost or economize in some other quarter.

[1] Hoover, T. J., Concentrating ores by flotation: London, pp. 161–162, 1912.

METALLURGY.

CONCENTRATION.

PROGRESS OF FLOTATION CONCENTRATION.

A brief description of various ore flotation processes was given in Part I of Mineral Resources for 1908 (pp. 251–256), and to that summary the reader is referred for further information. Since that time, however, various improvements have been made in the different processes, and new processes have been invented. Most of these, together with the Froment, Potter, Delprat, Cattermole, and Sulman, Picard & Ballot, and other processes have been acquired by the Minerals Separation Co. (Ltd.), and that company has recently been merged with the De Bavay Sulphide Process Co., thereby acquiring the rights to the patents of the latter company outside of Australia. The American rights of the Minerals Separation Co. are handled by the Minerals Separation American Syndicate (Ltd.).

AUSTRALIA.

In Australia flotation concentration continues to make progress, the advance being along the line of betterment of plants and processes already in use and of perfecting selective flotation by which the sulphides are successively floated and thus are separated as well as concentrated, the latter being the end attained in ordinary flotation which necessitates table separation later.

The Zinc Corporation, at Broken Hill, has installed a plant of 500 tons, weekly capacity for treating lead-zinc slime by the Horwood process. This material is too fine for separation by hydraulic means, and in its present shape is desirable neither to zinc smelters nor to lead smelters. By the Horwood process the slimes are dried and subjected to slight roast, which superficially transforms the lead, copper, and iron sulphides to sulphates and oxides, whereas the zinc sulphide is practically unaltered. When treated by the usual flotation processes, the zinc sulphide is readily separated from the remaining minerals which are now easily wetted, and sink in the flotation tanks. The plant was in successful operation during the latter six months of 1913 and produced 4,400 long tons of zinc concentrates assaying 46.61 per cent zinc, and 2,162 long tons of lead concentrates assaying 32.47 per cent lead and 38.6 ounces silver to the long ton. This process of selective flotation has also been successfully worked on Tasmanian ores and promises to be useful elsewhere on complex sulphide ores containing zinc.

The Zinc Corporation has also constructed at the South Blocks mine a plant of 100 tons, daily capacity, embodying the Lyster process for calcitic slime treatment by selective flotation, in which the galena is floated first by agitation with a little eucalyptus oil in a solution of iron and calcium sulphates; the blende may be afterwards recovered by oil flotation. At present the process is used only upon lead slimes that were formerly thrown away, and the final recovery is reported to be about 90 per cent of the total lead in the ore treated, as compared with 83 per cent before the installation of the supplementary process.

At the Broken Hill South mine another system of selective flotation, known as the Owen process, has been installed in a new plant the first unit of which has 500 tons, weekly capacity. By this process the galena is floated first by aeration at high temperature without acid, and the blende is subsequently recovered by the Minerals Separation process. Three other units will be added later.

The Proprietary Co. has an experimental unit employing the Bradford process of selective slimes flotation. By agitating the slimes in a solution of common salt with a little sulphuric acid, blende is floated first, leaving the galena as a residue. It is claimed that the process yields a high degree of concentration.

The Sulphide Corporation at the Central mine remodeled the slimes plant to the use of a selective flotation system to treat both dump and current slimes. Additional flotation plants were under construction by the British and the Amalgamated Zinc companies.

UNITED STATES.

In the United States flotation concentration is rapidly coming into use, largely as a result of its successful application at Butte, Mont. In addition to being installed at the large Inspiration Consolidated mill in Arizona; at the mill of the Tennessee Copper Co. at Ducktown, Tenn.; at the National Copper Mining Co.'s mill at Wallace, Idaho; and at other copper properties, it is being more and more employed in the two largest lead districts, the disseminated lead district of southeastern Missouri, and the Cœur d'Alene district of Idaho.

The complex nature of the zinc ores of the Butte district has made their successful concentration very difficult. The Butte & Superior Co., after adequate tests, installed the Hyde flotation process in the new concentrating plant erected at the mine during 1912. The essentials of the process as given herewith are furnished by the patent specifications (U. S. patent No. 922,085):

> The pulp is mixed with acid before thickening in a tank. It has been found that adding the acid in advance cuts down the amount required and promotes the settlement of colloidal material, which may be further aided, if necessary, by adding copperas, alum, or some other coagulant. From the thickener the pulp is pumped to the first-treatment tank, where oil is added and the entire mass agitated. A float concentrate is then taken off, and the gangue goes to the second-treatment tank, where the process is repeated, and thence to the third-treatment tank, where the pulp is agitated and a third concentrate taken off. From this tank the gangue is discharged as a final tailing.
>
> There is considerable silica mixed with the first concentrates, so they are all recleaned in a second device, the concentrates from which are the final product, while the tailing is all sent back through the system again.

The results of operation of the process are given in the Engineering and Mining Journal,[1] from which are abstracted the following notes regarding the concentration plant. The plant consists of two units, each of 500 tons' capacity and each equipped with crushing plant, jigs, hydraulic classifiers, a slime plant for oil flotation, and Wilfley tables, which are used only to separate the lead from the zinc. The ore is first reduced by rolls to six mesh, and after jigging the tailings are reground to 40 mesh and the tailings from the fine jigs ground to 100 mesh and treated by oil flotation. The pulp is thickened to three

[1] Eng. and Min. Jour., vol. 93, p. 1068, June 1, 1912.

parts water and one part ore and is mixed with a small quantity of oil and sulphuric acid and agitated.

The Minerals Separation Co. filed suit in the United States District Court at Butte for infringement of patents controlled by that company against James H. Hyde and the Butte & Superior Co. On July 29, 1913, a decision was handed down in favor of the plaintiff. On appeal, the United States Circuit Court of Appeals at San Francisco, May 4, 1914, reversed the decision of the lower court, remanded the case with instructions to dismiss, and later denied the motion for a rehearing, thus ending litigation as to the basic process.

The new concentrating plant of the Timber Butte Milling Co. to handle the ore from the Elm Orlu mine, which went into commission at Butte, Mont., in June, 1914, is described in the Mining and Engineering World.[1] The ore to be treated averages 20 per cent zinc, 1½ per cent lead, 2½ per cent iron, 0.8 per cent copper, and 7–8 ounces in silver, and 20–80 cents in gold to the ton. There will be produced high-grade zinc, lead, and lead-iron concentrates. The capacity of the plant is at present 400 tons a day, but space has been left to double the capacity. Reinforced concrete framework and concrete floors are used, and an elaborate fire protection system is installed. The crushing department is equipped with breakers, disk crushers, and rolls. The ore next passes through the first stage of table concentration, where, by means of classifiers, concentration tables, and regrinders, it is prepared for flotation. The Minerals Separation process is used. There are 2 flotation tanks, an 8-cell and an 11-cell, of 150 and 600 tons' capacity, respectively. The separation of the concentrates is finished on concentration tables. The power is electric throughout, and is supplied by the Montana Power Co. Water for mill purposes is obtained from a distance of 2 miles.

A million-ton pile of tailings on the site of the old Butte Reduction Works, containing silver and copper, will be worked by the Minerals Separation process. The preliminary tests gave satisfactory results, and plans have been drawn for the plant.

The Macquisten flotation plant, installed in 1910 at the Morning mill of the Federal Mining & Smelting Co., at Mullan, Idaho, to treat zinc-barite-siderite middlings from the tables and vanners, has been doubled in capacity. Originally consisting of 120 Macquisten tubes, a second unit, utilizing 128 tubes, was completed in 1913, more than doubling the capacity of the plant and enabling it to handle 200 tons of feed per day. The successful operation of the Macquisten process at the Morning mill and the good results achieved by flotation at Butte, Mont., led to the very general introduction of the flotation process in the Cœur d'Alene district as an adjunct of the wet concentration mills to deal with the zincky middlings which have long been a difficulty. Plants using a hot-acid process, said to be a modification of the Delprat process, have been installed at the Green Hill and Hercules mills. A plant of 50 tons' capacity, employing Callow flotation machines, which use a small quantity of creosote and pine oil with aeration, has been erected at the Hunter mill at Mullan and is to be enlarged in capacity. A 350-ton plant, using the same system, has been installed in the Morning mill. It is reported the Callow machines

[1] Cohn, J. E., Timber-Butte new concentrator: Min. and Eng. World, vol. 40, pp. 1049–1052, 1914.

are also being installed in the Success mill and at the Cleveland-Green Hill mills and are being tried out at the Hecla mill.

In southeastern Missouri flotation plants were added to the three mills of the St. Joseph Lead Co., at Bonne Terre, Leadwood, and Doe Run. The process used is similar to that which has been in use for some time by the Federal Lead Co. at Flat River. According to press accounts, flotation machines are likewise installed in the National and Doe Run mills.

In the Joplin district experimental work is proceeding upon the zinc-lead ores under the joint auspices of the Bureau of Mines and the Missouri Bureau of Geology and Mines, to ascertain whether these ores are amenable to flotation methods.

SMELTING.

CHEMICAL REDUCTION.

The high zinc content of the copper ores of the eastern part of the Shasta County copper district of California has caused much trouble in smelting in the blast furnace so that some plants have shut down and others have installed bag houses to filter out the zinc fumes, which, as noted elsewhere, are accumulating with no present available use. At the Afterthought mine, S. E. Bretherton [1] has developed a leaching process which he summarizes as follows:

> Grind the ore, roast, regrind, leach out zinc with ammonia and carbon dioxide, precipitate from the solution any copper which has been dissolved with the zinc, and put back in the residue. Smelt the residue for the recovery of copper or lead, with the gold and silver. The ammonia and excess carbon dioxide are distilled from the solution containing the zinc and recovered for further use. As the ammonia is being distilled, the zinc is precipitated as a pure white basic zinc carbonate, filtered out, and then calcined to zinc oxide, or the basic zinc carbonate can be reduced direct to either zinc chloride or spelter.

The testing plant is of laboratory size, with a capacity of 150 pounds of ore, but it has been in operation for two years and is reported to have yielded satisfactory results. In a test run in February and March, 1914, the zinc extraction varied from 80 per cent on 18.6 per cent ore to 85 per cent on 21 per cent ore.

ELECTROCHEMICAL REDUCTION.

The Malm process of dry chlorination for complex sulphide ores, dissolving the chlorides, precipitating the other metals by zinc, and recovering the zinc by electrolysis, was described in the chapter on zinc in Mineral Resources of the United States for 1910, page 282. The plant then under construction at Georgetown, Colo., was never operated, but early in 1914 it was taken over by the Bunker Hill & Sullivan Co. and removed to Wardner, Idaho, where it is now being reerected.

Another plant using the Malm process has just been completed by the Northwestern Metals Co., 2 miles west of Helena, Mont. With

[1] Bretherton, S. E., Preparation of ore containing zinc for the recovery of other metals such as silver, gold, copper, and lead by the elimination and subsequent recovery of the zinc as a chemically pure zinc product: Am. Inst. Min. Eng. Bull. 80, pp. 1481–1487, 1913; also The treatment of complex ores by the ammonia-carbon dioxide process: Am. Inst. Min. Eng. Bull. 91, pp. 1771–1777, 1914.

these two plants in active operation, the question of the economic availability of the Malm process for the treatment of complex sulphide ores should soon be settled.

ELECTROTHERMIC ZINC SMELTING.

The Hartford Continuous Zinc Furnace Co., owners of the Woolsey McA. Johnson electric zinc furnace patents, established an experimental plant at Hartford, Conn., where for several years developmental work was carried on. At the close of 1913, practical success was claimed for the furnace, a larger furnace was installed, and smelting campaigns open to the public were inaugurated. Successful test runs were made upon complex sulphide ores from various Western States—Colorado, Utah, Montana, and California. The furnace in its present stage is not advocated for the smelting of straight zinc ores, but rather of those mixed sulphide ores in which a penalty is exacted for the zinc. It is calculated that the greater expense of electrothermic smelting will be more than counterbalanced by the recovery of the zinc, the higher recovery of the other metals, and the escape of the zinc penalty. Figures are given of a 42-day run of the furnace in which 60,525 pounds of mixed sulphide ores were treated, with the recovery of 17,245 pounds of spelter, 3,478 pounds of copper (as 12 per cent copper matte), and 2,437 pounds of lead bullion, containing 116 ounces of silver. The recovery of zinc for the entire run was 86.1 per cent. It is claimed that the zinciferous copper ores of Shasta County, Cal., are easily handled by the electric furnace. Early in 1914 the American rights to the Johnson patents were taken over by the Johnson Electric Smelting (Inc.), and contracts have been let for the construction of a 10-ton demonstration furnace at Keokuk, Iowa, using power from the new hydroelectric installation of the Mississippi River Power Co.

In the experimental work authorized by the Government of the Dominion of Canada in the hope of finding a reduction process for the complex zinc sulphide ores of British Columbia, at McGill University, Montreal, under the direction of Dr. Alfred Stansfield, the preliminary laboratory experiments have been completed and experiments on a commercial scale are now under way at Nelson, British Columbia, in which the experimental electrothermic smelter, formerly operated by the Canada Zinc Co., is used, but no results are ready for publication. Negotiations looking to the installation of a Johnson electric furnace at Nelson in furtherance of the work are understood to have fallen through, as already noted.

ZINC SMELTERS.

The following table gives the zinc-smelting capacity of the United States as determined by a recent canvass. Those plants which have an "A" in the column headed "Acid plant" operate sulphuric-acid plants, either at the smelter or elsewhere as indicated in the footnotes.

List of active zinc smelters in the United States, showing capacity in 1913, by companies and States.

Company and State.	Location.	Acid plant.	Retorts at close of 1913.	Additional retorts contemplated in 1914.
COLORADO.				
United States Zinc Co.	Pueblo.		1,920	
ILLINOIS.				
American Zinc Co. of Illinois	Hillsboro	A	3,200	800
Collinsville Zinc Smelting Co.	Collinsville		1,536	
Granby Mining & Smelting Co.	East St. Louis	A		3,240
Hegeler Bros.	Danville	A	1,800	1,800
Illinois Zinc Co.	Peru	A	4,640	
Matthiesson & Hegeler Zinc Co.	La Salle	A	5,256	912
Missouri Zinc Co.	Beckemeyer		192	
Mineral Point Zinc Co.	Depue	A	6,800	2,280
National Zinc Co.	Springfield	A[a]	3,200	
Robert Lanyon Zinc & Acid Co.	Hillsboro	A	1,840	
Sandoval Zinc Co.	Sandoval		996	
Total			29,460	9,032
KANSAS.				
Altoona Zinc Smelting Co.	Altoona		3,960	
American Zinc, Lead & Smelting Co.	Caney		3,648	
Do.	Dearing		3,840	
Chanute Zinc Co.	Chanute		1,280	
Edgar Zinc Co.	Cherryvale		4,800	
Granby Mining & Smelting Co.	Neodesha		3,760	
La Harpe Spelter Co.	La Harpe		1,856	
Pittsburg Zinc Co.	Pittsburg		910	
Prime Western Spelter Co.	Gas	A[b]	4,768	
Total			28,822	
MISSOURI.				
Edgar Zinc Co.	St. Louis		2,000	
Nevada Zinc Co.	Nevada		672	
Total			2,672	
OKLAHOMA.				
Bartlesville Zinc Co.	Bartlesville		5,184	
Do.	Collinsville		8,064	
Lanyon-Starr Smelting Co.	Bartlesville		3,456	
National Zinc Co.	do.		4,480	
Tulsa Fuel & Manufacturing Co.	Collinsville		6,232	
Tulsa Spelter Co.	Sand Springs			4,000
Total			27,416	4,000
PENNSYLVANIA.				
American Zinc & Chemical Co.	Langeloth	A		3,456
New Jersey Zinc Co. (of Pennsylvania)	Palmerton		5,760	
WEST VIRGINIA.				
Clarksburg Zinc Co.	Clarksburg		2,736	
Grasselli Chemical Co.	do.	A[c]	5,760	
Do.	Meadowbrook	A[c]	6,912	
Total			15,408	
Total for all States			111,458	16,488

[a] The National Zinc Co. has zinc-roasting furnaces at Argentine, Kans., where the sulphur gases are utilized in an acid plant, the roasted concentrates being shipped to the smelter at Springfield, Ill.

[b] The Prime Western Spelter Co. is constructing roasting furnaces and an acid plant at Tiltonville, Ohio.

[c] The Grasselli Chemical Co. operates acid plants in connection with its zinc-roasting furnaces at Grasselli, Ind., Cleveland, Canton, and Lockland (near Cincinnati), Ohio, and Newcastle, Pa., the roasted zinc concentrates being shipped to the smelters at Clarksburg and Meadowbrook, W. Va.

From the 111,458 retorts listed above as in existence at the close of 1913, there should be deducted 5,774 retorts at plants either idle during the year, or just completed at the close of the year, or engaged in smelting secondary material, which leaves 105,684 retorts as effective at the close of the year. Owing to the low price of spelter during the latter part of 1913 many smelters closed down, so that a canvass disclosed only 85,051 retorts in active operation working upon ores during December, 1913.

In the foregoing list there are a few smelters which treat only secondary materials such as zinc ashes, skimmings, and galvanizers' drosses. There are also a few which recover about equal quantities of spelter from ores and from secondary materials, as well as several more which treat minor quantities of secondary materials. There are two other zinc smelting plants in the country which obtain spelter by distillation of zinc ashes and drosses in large graphite crucibles and condensers somewhat similar to those used in the Faber du Faur furnaces for recovering zinc from the zinc crusts in lead desilverization. These are the William Cramp & Sons Ship & Engine Building Co., of Philadelphia, Pa., and the Trenton Smelting & Refining Co., of Trenton, N. J.

SMELTER CHANGES, 1913.

Numerous additions to capacity as well as some reductions were made during 1913, and substantial additions are planned for 1914 and are now under construction.

In Illinois, at Hillsboro, the American Zinc Co. of Illinois added 1,600 retorts to the same number which were in operation at the beginning of the year. Another 800 retorts now under construction will complete the plant as originally planned. Hegeler Bros. are adding 1,800 retorts, and the new plant of the Granby Mining & Smelting Co. at East St. Louis, is under construction. It will have 3,240 retorts when finished. The Matthiesson & Hegeler plant is making an addition of 912 retorts. The Mineral Point Zinc Co. at Depue added 2,280 retorts in 1913 and has under construction the same number, making a total of 9,080 retorts when complete, as compared with 8,064 retorts at the Collinsville plant of the Bartlesville Zinc Co., the largest zinc smelter at present. The Robert Lanyon Zinc & Acid Co. added 240 retorts.

In Kansas the Altoona Zinc Smelting Co. added 660 retorts and the La Harpe Spelter Co. added 1,216 retorts. During the year the gas plant of the Kansas Zinc Co., with 2,520 retorts, was dismantled and removed, so that Kansas no longer holds first place in actual number of retorts.

In Oklahoma the Tulsa Spelter Co., allied with the La Harpe Spelter Co., began the erection of a plant at Sand Springs. There will be five blocks of 800 retorts each, and the zinc ore will be roasted in a Rapp furnace. Two blocks of 1,600 retorts will be completed and started up about July, 1914. It is expected that the smelter will be completed by the close of the year. It is believed that the gas supply will be ample in this vicinity for many years.

Construction work was pushed on the smelter of the American Zinc & Chemical Co. at Langeloth, Pa., and the initial unit, consisting of

two Hegeler roasting kilns with the corresponding acid plant and four blocks containing 3,456 retorts, will be ready for operation before the close of 1914; in fact, the manufacture of sulphuric acid began in August, 1914. This plant will be enlarged as required by the closing down of affiliated Oklahoma smelters when the gas supply fails.

The Prime Western Spelter Co. is constructing zinc-roasting furnaces and an acid plant at Tiltonville, Ohio. There will be two kilns with a monthly capacity of 2,000 tons of ore. Distillation furnaces in connection are contemplated, but their construction has been indefinitely postponed.

NEW ZINC OXIDE PLANT.

The Western Zinc Mining & Reduction Co., at Leadville, Colo., began the erection of a zinc oxide works with capacity sufficient to handle 50 tons of Leadville zinc carbonate ore daily. This is the first unit; additional units will be constructed as needed until the complete plant has a capacity of 200 tons. The plant consists of a crushing department, 8 Wetherill oxide furnaces, a 680-foot settling flue, and a bag room with 288 bags. Straight zinc oxide will be made, and ore containing more than 14 per cent of zinc and not over one-half of 1 per cent of lead is purchased. As zinc smelters in times of low prices do not desire Leadville carbonate ore lower than 18 or 20 per cent, the new plant makes available large bodies of ore heretofore unmarketable. The plant was ready for operation in July, 1914.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

The world's production of spelter in 1913 was again the largest in history, exceeding that of the record output of 1912 by 23,590 tons, or 2.2 per cent. The greatest increase was contributed by Germany, which exceeded its production of 1912 by 13,281 tons, or 4.4 per cent. The United States made a gain of 7,870 tons, or 2.3 per cent. Austria and Italy were third with a gain of 2,319 tons, or 10.7 per cent. Gains were made also by Australia, Great Britain, and Holland. Belgium's production decreased 2,750 tons, or 1.2 per cent. France and Spain's production decreased 1,254 tons, or 15.7 per cent. Poland's production decreased 1,270 tons, or 13.1 per cent. The output of the United States was again 31.7 per cent of the total production of the world. The next largest producers were Germany, with 28.6 per cent of the world's production to its credit, and Belgium with 19.9 per cent.

The following totals, apportioned according to the country where smelted and not according to the source of the ore, are the figures of Henry R. Merton & Co., of London, taken from the annual statistical publication for 1913 of the Metallgesellschaft, the Metallurgische Gesellschaft, A.-G., and the Berg und Metallbank Aktiengesellschaft, of Frankfort on the Main, Germany, except that the figures for the United States are those of the United States Geological Survey:

The world's production of spelter, 1905–1913, by countries, in short tons.

Country.	1905	1906	1907	1908	1909	1910	1911	1912	1913
Australia	.....	1,131	1,098	1,198	.....	560	1,904	2,531	4,105
Austria and Italy	10,315	11,883	12,522	14,063	13,931	14,666	18,602	21,609	23,928
Belgium	160,496	168,067	170,307	181,851	184,194	190,233	215,050	220,678	217,928
France and Spain	55,524	59,293	61,438	61,512	61,859	65,191	70,791	79,543	78,289
Germany	217,356	225,997	230,058	239,062	242,594	251,046	276,008	298,794	312,075
Great Britain	56,140	57,971	61,286	60,029	65,422	69,531	73,806	63,086	65,197
Holland	15,176	16,150	16,526	19,017	21,548	23,121	25,059	26,380	26,811
Norway	.....	.....	.....	.....	.....	.....	7,363	8,959	10,237
Poland	8,422	10,595	10,735	9,740	8,758	9,514	10,952	9,659	8,389
United States	203,849	224,770	249,860	210,424	255,760	269,181	286,526	338,806	346,676
Total	727,278	775,857	813,830	796,896	854,066	893,046	986,061	1,070,045	1,093,635
United States percentage of world's production	28.0	29.0	30.7	26.4	29.9	30.1	29.1	31.7	31.7

PRODUCTION OF SECONDARY SPELTER IN EUROPE.

The following table of the production of secondary spelter in Europe is calculated to short tons from a table published by Rudolf Wolff, Kreuger & Co., of London. It includes the output of the larger regular producers only. The production of the United States is included for comparison.

Production of secondary spelter in Europe and United States, 1905–1913, in short tons.

Country.	1905	1906	1907	1908	1909	1910	1911	1912	1913
Austria-Hungary	3,505	3,674	3,931	3,315	3,102	2,934	3,282	3,282	2,822
Belgium	4,044	4,473	3,620	4,295	3,564	3,406	3,288	4,138	3,366
Denmark	.....	.....	.....	.....	.....	224	1,184	1,353	1,374
France	14,304	14,898	15,130	20,309	20,467	20,691	24,345	25,077	20,490
Germany	9,689	11,040	11,316	13,273	14,943	15,133	16,022	21,093	18,405
Great Britain	7,913	7,644	7,168	8,714	8,454	7,605	9,296	7,963	5,992
Holland	2,268	2,800	2,957	2,923	2,184	2,610	2,722	3,730	2,822
Russia	1,680	.....	1,680	1,680	.....	.....	.....	.....	.....
United States	.....	.....	18,841	16,970	33,040	41,223	40,513	52,251	50,005
Total	43,403	44,529	64,643	71,479	85,754	93,826	100,652	118,887	105,995

THE ZINC INDUSTRY AS AFFECTED BY THE WAR IN EUROPE.

The following notes on the zinc industry of the United States in its relation to the markets of the world, particularly as affected by the war in Europe, were issued in a press bulletin on August 22, 1914, and are incorporated here for the sake of their general interest:

Decreased European production resulting from war.—By a queer coincidence the great smelting centers of continental Europe are in regions where active fighting is now going on or may be expected in the near future. The zinc smelters of Upper Silesia are in the extreme southeastern portion of Prussia, mostly in the Kattowitz, Beuthen, and Tarnowitz districts, which are adjacent to one another and lie within 5 or 10 miles of the Polish-Russian border and near the corner of Russia, Austria, and Germany. The two smelters in Russian Poland are just across the border from the Silesian smelters. They all seem destined soon to be compelled to suspend or decrease operations on account of military activities, and in any event their output certainly can not reach the outside world. The same thing is true of the smelters in Rhenish Prussia and Westphalia, some of which are very near and most of which are within 100 miles of Liege. In Belgium all but three or four of the zinc-smelting plants lie between Verviers and Liege or are strung along the valley of the Meuse be-

tween Liege and Namur, and their industrial prospects can well be imagined. The zinc smelters of France lie outside of the territory where active military operations are likely and so will probably suffer only from scarcity of labor as the employees are called to the colors and from derangements of transportation. The same is true of the zinc smelters in England, but those of Austria-Hungary will, of course, be put out of commission. Other small smelters in Europe, Australia, and Japan will possibly not be affected, except as transportation is interrupted. From these observations it can be seen that the zinc-smelting industry of Europe will be in a sadly demoralized condition while the war continues and for some time thereafter.

In 1910 Germany had 24 zinc-smelting plants in Upper Silesia, and 10 in the Rhine district of Westphalia; Great Britain had 17 plants; Belgium had 13 plants; and France 5 plants. The production of these countries since 1905 is given on a preceding page of this report.

If the war continues for one year the output of these countries for that period would, at a conservative estimate, be only about 250,000 tons—a loss of nearly 500,000 tons for the year. The continental spelter market will also be demoralized, however, so it may be that the reduced production will still be ample. Apparently England's industrial activities after the first readjustments are over may not be seriously restricted.

Increased American smelter capacity.—The war but serves to emphasize a condition which already confronted the zinc industry of the United States. The zinc-smelting capacity and spelter production of this country has been increasing of late years faster than the consumption, as the following table will show:

Zinc-smelting capacity, production and apparent consumption of spelter in the United States, 1908–1914.

Year.	Retorts at close of year.		Production.	Apparent consumption.
	Number.	Estimated maximum annual capacity.		
		Short tons.	*Short tons.*	*Short tons.*
1908	93,958	404,960	210,424	214,167
1909	94,328	400,681	255,760	270,730
1910	93,722	398,105	269,184	245,884
1911	85,018	361,327	286,526	280,059
1912	107,948	458,779	338,806	340,341
1913	111,458	473,697	346,676	295,370
1914	127,946	543,771	[a] 175,058	[a] 149,363

[a] For first six months of year.

The actual gain in capacity is even more than is indicated in the table, for in the earlier years a number of small, antiquated smelters that had been idle for several years were included in estimating the total capacity, whereas in the later years almost all such smelters have been dismantled or abandoned completely, and there have been more new modern additions than ever before in the same time. It is to be borne in mind that a certain portion of the capacity is taken up in the redistillation of zinc drosses, and that some plants do not yield full capacity because they treat lower-grade ores, so that the spelter produced from ore always falls much short of the maximum capacity. On the other hand, the new zinc oxide plant at Leadville, Colo., will take a great deal of the low-grade carbonate ore away from the zinc smelters, so that the capacity per retort will be increased because of the higher grade of the remaining supply; and the introduction of ore flotation in the Western States will probably raise the grade of zinc concentrates from that section, likewise increasing the capacity per retort.

Increased mine reduction of zinc in the United States.—The following table shows that the production of zinc at the mines is steadily increasing:

	1911	1912	1913
Joplin district	137,633	152,465	146,474
New Jersey	77,445	69,755	84,122
Colorado	47,304	66,111	59,673
Montana	21,905	13,459	44,337
Upper Mississippi Valey	33,939	37,115	32,346
Other States	27,034	39,911	51,430
	345,260	378,816	418,382

The largest increase in sight comes as a result of the application of ore flotation concentration in Montana, but an increase due to the same cause is to be looked for in Idaho and possibly in Utah. In Montana the Butte & Superior mill is now producing at the rate of 50,000 tons of zinc a year, and the new Timber Butte mill, which has just gone into operation, should raise the State output to 70,000 tons a year, or if, as planned, another unit is added to this mill the State output may rise to 90,000 tons and more by 1915. In Colorado the new zinc oxide plant at Leadville is reported to be purchasing 14 per cent zinc carbonate ore, as against a minimum of about 20 per cent ore purchased by zinc smelters. As the Leadville carbonate ore is not amenable to concentration this means a large increase in the available zinc ore resources of that region. Another source of zinc which will be made available in the future is zinc-bearing copper ore, the zinc content of which at present either makes the ore unsalable or, when the ore is smelted for the copper, collects as flue and bag-house dust, for the recovery of the zinc from which there is at present no suitable process. Much ore of this sort is mined in Shasta County, Cal., and such zinciferous dusts are accumulating in large quantities at the smelters in that region.

Zinc ore imports.—With the establishment of peaceful conditions in Mexico, it is to be expected that imports of zinc ore from that country will again reach large proportions, and likewise the imports from Canada may perhaps become larger even than they were in 1909, before the imposition of the tariff. With the closure of the Belgian and other continental markets to the zinc concentrates from Broken Hill, Australia, those concentrates may be partly diverted to the United States. If a sufficient foreign market becomes available, the surplus smelter capacity in the United States might perhaps be employed in smelting foreign zinc ores under bond, and a business might grow up similar to that which exists in lead smelting. If an extensive business of smelting zinc in bond grows up, it is likely that it would be found desirable to build special smelters for that work at tidewater in the vicinity of New York City, convenient to fuel supplies, to acid markets, and to transportation lines to Mexico, and, through the Panama Canal, to British Columbia and Australia. This work could be done only at the expense of domestic production of zinc ore, for the present domestic production more than equals the apparent domestic consumption as spelter and as zinc oxide, and bids fair to exceed it greatly in a year or two unless consumption is increased by development of export trade and galvanized-iron products.

Possible foreign zinc markets for American zinc.—The opening of the Panama Canal, the necessary establishment of American lines of transportation to South America, Australia, and the Orient, and, in the present crisis, the large dependence of those continents on the United States for their supply of zinc all make for a quick commercial introduction of the products of the United States zinc industry to those continents—and introduction which under other conditions might have taken years.

It is known that large stocks of spelter exist in Europe. The Ironmonger, of London, gives the stocks at the end of March as 73,000 long tons and quotes an estimate of 80,000 long tons for the end of April. At that rate the stocks on hand June 30 must have been considerably over 100,000 short tons, compared to 64,039 short tons in the United States. The greater part of the European stocks, however, must have been held in the interior and must now be isolated, so that for the term of the war they may be disregarded. After the war what remains of these stocks will become available again and will possibly operate to depress prices, but in the meantime the United States zinc operators will have had the opportunity to dispose of domestic stocks and to become established in the foreign markets.

The following statistics of imports and exports have been taken from the official publications of the countries concerned and are given for 1912 because official figures for 1913 are not available for all the countries. The figures for the "A B C" group of South American States and the partial figures for Venezuela and Uruguay have been kindly furnished by the Pan-American Union. Statistics for the other South American States are not available.

Imports of zinc into various countries in 1912, in short tons.

	Zinc slabs and sheets.	Galvanized sheets and wire.	Plain and galvanized wire and sheets.
Canada	8,910	79,792	.....
Mexico	2,686	7,534	.....
South America (in part):			
Argentina	3,917	62,360	.....
Brazil	2,960	25,962	.....
Chile	665	31,508	18,345
Venezuela	.....	864	.....
Uruguay	.....	±8,030	.....
	7,162	128,723	18,345
From United States	475	39,031	11,449
British South Africa	4,930	91,317	.....
Australia	3,541	135,317	.....
Total	27,229	442,683	18,345

Zinc exports, in 1912, from Germany, Belgium, France, and Great Britain, in short tons.

To—	From Germany.		From Belgium.		From France.		From Great Britain.		Total.	
	Slabs and sheets.	Galvanized iron.	Slabs and sheets.	Galvanized iron.	Slabs and sheets.	Galvanized iron.	Slabs and sheets.	Galvanized iron.	Slabs and sheets.	Galvanized iron.
Canada	822	.....	2,903	.....	.....	.....	465	29,398	4,190	29,398
Mexico	.....	.....	2,115	.....	.....	837	.....	1,319	2,115	2,156
Central America and West Indies	.....	.....	202	97	.....	5,261	.....	4,812	202	10,170
South America	280	4,370	4,897	8,835	5,280	2,113	.....	123,263	10,457	138,581
Africa	4,018	.....	9,288	.....	15,328	58,514	.....	71,592	28,634	130,106
Australia and New Zealand	.....	.....	2,547	60	.....	1,282	.....	143,525	2,547	144,867
Asia, Japan, and East Indies	5,720	1,758	5,956	5,446	8,502	13,708	4,152	287,360	24,330	308,272
	10,840	6,128	27,908	14,438	29,110	81,715	4,617	661,269	72,475	763,550

The foregoing table shows a foreign market for over 72,000 tons of zinc, of which about 30,000 tons consists of spelter in slabs and the remainder of zinc sheets. The American zinc industry should stand an excellent chance to take over the trade in zinc slabs and such part of the trade in zinc sheets as American zinc-rolling mills can furnish. The trade in galvanized-iron sheets is dominated by Great Britain, which controls 87 per cent of the total export trade in that commodity with the four countries concerned. In addition to over 65,000 tons of spelter smelted in her own plants, Great Britain in 1913 imported 150,000 tons, presumably used chiefly in making her enormous output of galvanized iron. It would seem that any expansion in Great Britain's foreign trade either in spelter and zinc sheets or in galvanized iron would entail the importation of more spelter from the United States. This country has the opportunity, therefore, to furnish the major part of 222,000 tons of spelter a year as long as the war lasts, together with whatever part of the spelter for the galvanized-iron trade of the southern continents and Asia it can acquire. The first demands will naturally come from Great Britain, and according to reports they have already begun. With the end of the war, however, the continental smelters will begin to compete strongly for that trade. The southern continents and Asia are more likely, therefore, to become steady outlets for our zinc products, and by the time the war closes American zinc should have obtained a permanent foothold in these markets, sufficient to take care of the surplus smelter capacity of the United States.

These calculations do not take into account the increased exports of zinc pigments that must come about, thus absorbing some of the domestic surplus zinc resources.

Moreover, the United States imports each year from Continental Europe about 2,500 tons of zinc dust. This supply of zinc dust is now cut off, and the dust has already greatly advanced in price. Zinc dust is produced at two American smelters and could easily be produced at others, so that no doubt the better prices will result in the whole demand being supplied from domestic sources, thus absorbing another portion of the surplus zinc ore.

IMPORTS AND EXPORTS.

WAREHOUSE TRANSACTIONS.

Zinc imported into the United States as metal or in ore may be entered for immediate consumption, in which case the duty is paid and the zinc goes direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. From warehouse the zinc may be withdrawn for consumption by payment of duty, or it may be smelted in bond, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The zinc entered for immediate consumption and that withdrawn from warehouse for consumption make up the table below of imports for consumption, which are expressed in the same terms in which they were imported. The zinc imported for consumption may be actually used in the country or it may be manufactured and exported, in which case the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table below, showing foreign zinc exported in manufactures with benefit of drawback, the zinc is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the articles exported with benefit of drawback. The foreign zinc given in the table below as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse. A somewhat more detailed explanation of warehouse transactions is given in the chapter on lead in this volume. The following tables of imports and exports of zinc and of zinc remaining in warehouse are made up from the publications and records of the Bureau of Foreign and Domestic Commerce.

The quantity of zinc remaining in warehouse at the close of the years previous to 1909 has been negligible, but since all zinc ore became dutiable on August 6, 1909, the quantity of bonded zinc has largely increased.

Practically all the zinc remaining in warehouse, as given in the table below, is credited to the port of Kansas City, Mo., and is in possession of the bonded zinc smelters of Kansas and Oklahoma.

Zinc remaining in warehouse Dec. 31, 1909–1913.

Year.	Ore and calamine.			Blocks, pigs, and old.	
	Short tons.	Zinc content.	Value.	Quantity.	Value.
		Pounds.		*Pounds.*	
1909	2,813	2,255,341	$36,384	78,667	$4,021
1910	2,603	2,572,122	61,730	61,146	3,406
1911	10,177	6,978,098	137,055	63,454	4,049
1912	3,076	2,479,565	62,089	.....	.....
1913	7,531	1,930,425	68,726	.....	.....

The figures for 1910 are exclusive of 2,627,939 pounds of zinc contained in 10,359 short tons of other ore entered at New York and valued at $131,397, and the figures for 1911 are exclusive of 8,911,376 pounds of zinc contained in 36,038 tons of other ore, valued at $178,228, all of which zinc was lost in smelting the ore, as explained later in the discussion of the general imports of zinc ore. Since 1912 the duties assessed on such ores having been refunded they are not carried on the bonded warehouse records.

IMPORTS.

Zinc imported and entered for consumption in the United States, 1902–1913, in short tons.

Year.	Block or pigs.		Sheets.		Old.		Value of manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1902	448	$36,536	68	$8,339	157	$8,299	$32,708	$85,882
1903	202	19,161	129	8,537	163	11,772	10,376	49,846
1904	341	34,211	17	2,230	36	3,247	10,394	50,082
1905	428	46,295	14	1,953	86	5,110	8,253	61,611
1906	1,021	240,632	22	3,236	79	7,647	2,904	254,419
1907	1,709	220,474	52	7,158	122	8,582	8,516	244,730
1908	776	78,160	37	4,570	37	2,014	5,645	90,389
1909	9,419	805,087	117	13,510	238	9,999	6,488	835,084
1910	989	95,410	255	36,741	73	5,685	1,526	139,362
1911	323	38,322	291	55,211	104	8,609	7,981	110,123
1912	10,719	1,239,574	728	102,073	147	13,748	8,489	1,363,884
1913	5,165	565,215	223	43,497	275	17,850	5,474	626,562

The foregoing table does not include zinc dust imported for consumption. Prior to August 6, 1909, zinc dust was entered free of duty under "articles in a crude state used in dyeing and tanning," and as such was not separately enumerated by the Bureau of Foreign and Domestic Commerce. Under the tariff of 1909 zinc dust bore a duty of $1\frac{3}{8}$ cents per pound and was separately enumerated under "imports for consumption," though included with spelter in the Monthly Summary of general imports. Under the tariff act of 1913 zinc dust bears an ad valorem duty of 15 per cent. The imports of zinc dust for consumption for the period August 6 to December 31, 1909, were 431,660 pounds, valued at $19,464. This quantity and value is included in the total for the year as given in the table below. The quantity of zinc dust imported for consumption in 1910 and its value are also as given in the table. The only statistics available for the time before August 6, 1909, are those of foreign countries relating to their exports of zinc dust to the United States. Among these countries are Germany, Belgium, France, Holland, and Denmark, but only in the reports of the first-mentioned country are the exports of zinc dust segregated from other exports. Germany furnishes much the larger part, amounting to about 95 per cent of the total imports of zinc dust. For this reason the zinc-dust exports from Germany to the United States from March 1, 1906, to August 5, 1909, inclusive, as compiled from the annual Statistik des Deutschen Reichs, Auswärtiger Händel, and shown in the following table, give a fair idea of the total consumption of zinc dust in the United States for that period.

Imports of zinc dust, 1906–1913, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1906[a]	1,818,576	$108,052	1910	2,985,088	$136,749
1907	1,893,090	106,386	1911	3,426,161	177,420
1908	2,625,238	136,136	1912	5,471,211	306,061
1909	2,520,740	130,662	1913	4,735,502	248,482

[a] March–December, 1906; for period preceding, zinc dust is not separately enumerated.

In view of the general interest in the importation of zinc ores, a table is given later, showing the entry of such ores from Mexico and Canada for 1904–1913 by calendar years. These general imports of zinc ores differ from "imports for consumption" by the difference in stock in bonded warehouse at the beginning and close of the year and by exports from warehouse.

Imports for consumption of zinc ore and calamine, 1909–1913.

Year.	Containing less than 10 per cent of zinc (duty, free).		Containing from 10 to 20 per cent of zinc (duty, ¼ cent per pound).		Containing from 20 to 25 per cent of zinc (duty, ½ cent per pound).		Containing 25 per cent or more of zinc (duty, 1 cent per pound).	
	Zinc content.	Value.	Zinc content.	Value.	Zinc content.	Value.	Zinc content.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1909[a]			333,144	$8,690	225,302	$5,632	9,390,620	$161,430
1910	31,899	$698	174,697	4,053	2,355,748	25,126	39,921,939	713,684
1911	77,383	1,411	377,884	8,705	1,128,238	16,914	6,697,107	120,756
1912	44,308	1,141	112,938	3,045	916,865	6,734	12,875,485	281,066
1913			[b] 90,924	2,067	[b] 618,568	4,395	[c] 8,185,029	193,014

[a] For period July 1–Dec. 31 only.
[b] For period Jan. 1–Oct. 3, 1913; Oct. 4–Dec. 31, included in class "containing 25 per cent or more of zinc."
[c] Includes all classes for period Oct. 4–Dec. 31, 1913.

The statistics of general imports as published by the Bureau of Foreign and Domestic Commerce are based on "consular invoice" or "declaration," which is only a close approximation to actual weights and values. The true weights and values of all dutiable articles are determined when the duties are paid, and the correction is applied as "additions by liquidation" or "deductions by liquidation." On free articles this correction is not made. Prior to 1909 zinc ore was in large part undutiable, and in that part of 1909 prior to August 6 a portion of the imports of zinc ore was free. The correction by liquidation for the dutiable zinc ore imported during 1909–1912 is available, but, owing to special instructions followed in one customs district, to apply the correction by liquidation would result in a considerable duplication of imports. The following figures are taken directly from the Monthly Summary of the Bureau of Foreign and Domestic Commerce without the liquidation correction:

General imports of zinc ore from Canada and Mexico, 1904–1913, in short tons.

Year.	Canada.		Mexico.		Total.	
	Ore.	Zinc content.	Ore.	Zinc content.	Ore.	Zinc content.
1904	.....	.....	2,264	.....	2,264	.....
1905	4,063	.....	18,074	.....	22,137	.....
1906	423	.....	59,991	.....	55,414	.....
1907	1,112	.....	102,005	.....	103,117	.....
1908	7,406	.....	46,351	.....	53,757	.....
1909	10,024	.....	104,826	.....	114,850	.....
1910	4,749	1,922	67,818	23,517	72,626	25,439
1911	2,359	947	36,847	14,986	39,116	15,933
1912	8,015	3,661	35,925	14,206	43,940	17,567
1913	8,899	3,498	17,493	6,163	[a]31,416	13,497

[a] Includes also 3,232 tons of ore from Europe, containing 2,440 tons of zinc and 1,792 tons from Siberia, containing 1,397 tons of zinc.

The foregoing figures showing imports of zinc ore in 1910 do not include 10,431 short tons of ore that carried 2,645,111 pounds of zinc as an accessory constituent, an average of less than 13 per cent, which was lost in smelting the ore and hence for the purpose of this report can not be classed with zinc ore imports so long as the present metallurgical treatment of that ore prevails. Similarly, the figures for 1911 are exclusive of 25,769 tons of other ore, carrying 6,283,437 pounds of zinc, and those for 1912 are exclusive of 18,245 tons of other ore, carrying 4,862,508 pounds of zinc. The duties on the zinc contents of this ore have since been refunded and the bonds canceled. The ore was shipped from South American ports and largely entered through the port of New York. It is shown in the monthly Summary of the Bureau of Foreign and Domestic Commerce under the heading of "Merchandise remaining in warehouse," mostly at New York. In 1913 such ores entered free and were not enumerated.

Zinc oxide imported and entered for consumption 1901–1913 in short tons.

Year.	Dry.	In oil.	Year.	Dry.	In oil.
1901	1,800	64	1908	2,318	105
1902	1,636	82	1909	3,060	268
1903	1,744	83	1910	3,069	168
1904	1,283	112	1911	2,506	274
1905	1,718	171	1912	2,675	262
1906	2,096	146	1913	3,291	142
1907	2,656	181			

Imports of old brass fit only for remanufacture, 1903–1913, in pounds.

[Average composition about one-third zinc and two-thirds copper.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	1,216,683	$154,260	1910	6,144,564	$786,684
1904	2,659,054	310,311	1911	3,605,106	445,116
1905	9,676,798	1,169,320	1912	6,596,957	639,045
1906	12,938,205	1,891,126	1913	8,726,142	907,521
1907	7,957,015	1,344,753			
1908	2,714,155	355,335	Total	66,907,354	8,581,925
1909	4,672,575	579,454			

EXPORTS.

DOMESTIC EXPORTS.

The practice of the Bureau of Foreign and Domestic Commerce is to class all exports of zinc articles made in this country as domestic exports, whether the zinc be of domestic or foreign origin. Hence, the following table of domestic exports is duplicated in part in a later table of foreign zinc in manufactures exported with benefit of drawback. The exports of zinc ore in the table below are of domestic origin and in recent years have all been from one mine in New Jersey. The exports of plates, sheets, pigs, or bars are likewise probably wholly domestic, since as shown later all the zinc in manufactures going out under drawback came in as blocks, pigs, and sheets, and the only manufacturing process which would put any of these into the class of exports referred to is rolling into sheets. But the zinc rolling mills in this country do not use foreign spelter, hence the conclusion that the plates, sheets, pigs, and bars of the table are of domestic origin. The zinc dross exports are no doubt in part of foreign origin, but in what proportion can not be determined. However, they are not duplicated in the drawback table. The exports of manufactures, of which the value is given, include the value of the whole of the manufactures exported with benefit of drawback, as well as whatever manufactures of domestic zinc may be exported.

Exports of domestic zinc ore and of domestic manufactures of zinc, 1902–1913, in short tons.

Year.	Zinc ore.		Plates, sheets, pigs, or bars.		Zinc dross.[a]		Value of manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1902	55,733	$1,449,104	3,237	$300,557	.....	.....	$114,197	$1,863,858
1903	39,411	987,000	1,521	163,379	.....	.....	71,354	1,221,733
1904	35,911	905,782	10,147	1,094,490	.....	.....	117,957	2,118,229
1905	30,946	848,451	5,516	682,254	.....	.....	159,995	1,690,700
1906	27,720	733,300	4,670	583,526	15,887	$1,103,706	204,269	2,624,801
1907	[b] 20,352	579,490	563	75,194	9,593	560,944	186,203	1,401,831
1908	[b] 26,108	877,745	2,640	250,254	8,405	467,403	88,485	1,683,887
1909	[b] 12,455	412,300	2,566	263,010	7,069	477,112	69,751	1,222,173
1910	[b] 19,711	649,425	3,990	426,560	4,729	380,950	101,336	1,558,271
1911	[b] 18,281	642,884	6,872	810,099	4,246	348,176	134,518	1,935,677
1912	23,349	823,997	6,634	864,292	205	17,985	140,027	1,846,301
1913	17,713	631,991	7,783	955,667	28	1,457	145,984	1,735,099

[a] Not separately enumerated prior to 1906.
[b] The exports consisted wholly of high-grade willemite ore from New Jersey.

Exports of zinc oxide, 1902–1913, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1902	5,358	$433,722	1908	12,008	$845,070
1903	7,215	578,215	1909	14,846	1,026,377
1904	8,157	628,494	1910	13,167	943,938
1905	11,280	810,203	1911	14,618	1,051,311
1906	15,578	1,149,297	1912	17,064	1,247,702
1907	13,257	1,069,924	1913	14,467	1,136,257

FOREIGN EXPORTS.

By foreign zinc exports is meant the exports of zinc of foreign origin which has been smelted or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Foreign and Domestic Commerce, shows the total zinc exported from warehouse during the last six years, the exports previous to that period being of insignificant proportions, and also the foreign zinc exported in manufactures with benefit of drawback for the same period. These two items—foreign zinc exported from warehouse and foreign zinc in manufactures exported with benefit of drawback—make up the total foreign zinc going out of the country. Zinc in warehouse and deductions by liquidation being disregarded, the difference between the sum of these two exports of zinc and the total imports of zinc constitutes the foreign zinc consumed in this country. It must be clearly understood in regard to this table that the zinc was not exported as zinc content of ore and blocks, pigs, etc., but as zinc smelted or manufactured from them. The reason for this is that the zinc in bonded customs warehouse is carried on the records until the bond is canceled in the same form in which the zinc was entered for warehouse. The zinc content of the foreign ore is, of course, exported as spelter. Under present customs regulations 90 per cent of the total zinc content must be exported to secure cancellation of bond. The quantities of zinc exported from warehouse are extact, but the quantities as given of zinc exported in manufactures under drawback are subject to wastage in manufacturing.

No record is kept of the form in which the zinc is actually exported, except of a portion of the articles manufactured from foreign zinc and exported with benefit of drawback. Unless the zinc is the constituent of chief value, the actual amount of zinc is not recorded. But each shipment on which drawback is claimed is accompanied by a manifest of the imported zinc which was used in making the articles as well as the duty paid thereon. From these manifests is made up the statement of the total quantity of foreign zinc which went into manufacturers exported with benefit of drawback, and for this reason the zinc is given in the form in which it was imported.

Exports of foreign zinc, 1905–1913, in pounds.

Year.	Exported from warehouse.					Exported in manufactures with benefit of drawback.
	Ore and calamine, zinc content.[a]		Blocks, pigs, and old.		All other manufactures.	Blocks, pigs, sheets, and all other manufactures.
	Quantity.	Value.	Quantity.	Value.	Value.	Quantity.
1905	.....	.....	38,753	$816	$1,015	.....
1906	.....	.....	2,779	252	1,962	4,469
1907	.....	.....	17,458	1,023	1,504	3,110,239
1908	.....	.....	16,748	964	4,635	2,468,365
1909	[a] 655,102	$6,429	12,569	752	521	610
1910	9,420,984	182,345	94,672	4,884	1,121	8,972,427
1911	21,636,946	476,233	915,823	21,141	2,701	6,157,328
1912	13,556,954	306,726	95,571	4,346	30,649	2,437,354
1913	11,812,921	214,437	1,240,769	66,919	6,231	14,918,040

[a] After Aug. 6, 1909.

CUSTOMS DUTIES ON ZINC.

TARIFF OF 1909 AND OF 1913.

The tariff act of 1909 had the following sections relating to zinc ore, zinc, and to compounds containing zinc:

PAR. 55. Zinc, oxide of, and white pigment containing zinc, but not containing lead, dry, one cent per pound; ground in oil, one and three-fourths cents per pound; sulphid of zinc, white, or white sulphide of zinc, one and one-fourth cents per pound; chloride of zinc and sulphate of zinc, one cent per pound.

PAR. 193. Zinc-bearing ore of all kinds, including calamine, containing less than ten per centum of zinc, shall be admitted free of duty; containing ten per centum or more of zinc, and less than twenty per centum, one-fourth of one cent per pound on the zinc contained therein; containing twenty per centum or more of zinc and less than twenty-five per centum, one-half of one cent per pound on the zinc contained therein; containing twenty-five per centum of zinc, or more, one cent per pound on the zinc contained therein: *Provided*, That on all importations of zinc-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

PAR. 194. Zinc in blocks or pigs and zinc dust, one and three-eights cents per pound: in sheets, one and five-eights cents per pound; in sheets coated or plated with nickel or other metal or solutions, one and three-fourths cents per pound; old and worn-out, fit only to be remanufactured, one cent per pound.

The tariff act of 1913 substituted ad valorem rates for specific duties and made the provision for smelting in bond applicable to all other metals as well as lead. The paragraphs relating to the various dutiable forms of zinc are as follows:

162. Zinc-bearing ores of all kinds, including calamine, 10 per centum ad valorem upon the zinc contained therein: *Provided*, That on all importations of zinc-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

163. Zinc in blocks, pigs, or sheets, and zinc dust; and old and worn-out zinc fit only to be remanufactured, 15 per centum ad valorem.

61. Zinc, oxide of, and pigments containing zinc but not containing more than 5 per centum of lead, ground dry, 10 per centum ad valorem; when ground in or mixed with oil or water, lithophone and white sulphide of zinc, 15 per centum ad valorem.

62. Zinc, chloride of and sulphate of, ½ cent per pound.

N. SUBSECTION 1. That the works of manufacturers engaged in smelting or refining, or both, of ores and crude metals, may upon the giving of satisfactory bonds be designated as bonded smelting warehouses. Ores or crude metals may be removed from the vessel or other vehicle in which imported, or from a bonded warehouse, into a bonded smelting warehouse without the payment of duties thereon and there

smelted or refined, or both, together with ores or crude metals of home or foreign production: *Provided*, That the bonds shall be charged with the amount of duties payable upon such ores and crude metals at the time of their importation, and the several charges against such bonds may be canceled upon their exportation or delivery to a bonded manufacturing warehouse established under paragraph M of this section of an amount of the same kind of metal equal to the actual amount of dutiable metal producible from the smelting or refining, or both, of such ores or crude metals as determined from time to time by the Secretary of the Treasury: *And provided further*, That the said metals so producible, or any portion thereof, may be withdrawn for domestic consumption, or transferred to a bonded customs warehouse, and withdrawn thereform, and the several charges against the bonds canceled upon the payment of the duties chargeable against an equivalent amount of ores or crude metals from which said metal would be producible in their condition as imported: *And provided further*, That on the arrival of the ores and crude metals at such establishments they shall be sampled and assayed according to commercial methods under the supervision of Government officers, to be appointed by the Secretary of the Treasury and at the expense of the manufacturer: *Provided further*, That antimonial lead produced in said establishments may be withdrawn for consumption upon the payment of the duties chargeable against it as type metal under existing law and the charges against the bonds canceled in a similar sum: *Provided further*, That all labor performed and services rendered pursuant to this section shall be under the supervision of an officer of the customs, to be appointed by the Secretary of the Treasury, and at the expense of the manufacturer: *Provided further*, That all regulations for the carrying out of this section shall be prescribed by the Secretary of the Treasury.

CONSUMPTION.

In the following tables, showing the consumption of spelter in the United States and in the world for the period 1898–1913, the figures of foreign consumption are computed from statistics published by the Metallgesellschaft for 1913. In those statistics consumption is calculated on the basis of production plus excess of imports over exports or minus excess of exports over imports, and altogether disregards smelter stocks. For the sake of comparison the consumption of the United States is calculated by both methods. Although in the long run the stocks carried over from one year are consumed in the next, and thus are equalized, it can not be gainsaid that for the individual year to take stocks into account gives greater accuracy. To obtain perfectly accurate figures of consumption, it would be necessary to consider the stocks in the hands of consumers and dealers and to take into account the secondary spelter consumed.

Consumption of primary spelter in the United States, 1907–1913, in short tons.

	1907	1908	1909	1910	1911	1912	1913
Supply:							
Stock Jan. 1—							
In bonded warehouses	.....	2	9	39	31	32	43
At smelters	3,824	26,364	19,613	11,167	23,201	9,049	4,474
Production	249,860	210,424	255,760	269,184	286,526	338,806	346,676
Imports	1,778	881	9,454	1,960	609	11,115	6,100
Total available	255,462	237,671	284,836	282,350	310,367	359,002	357,298
Withdrawn:							
Exports, foreign, from warehouse	9	8	334	4,758	11,276	6,286	6,027
Exports, foreign, under drawback	1,555	1,234	.....	4,486	3,079	1,219	7,459
Exports, domestic	563	2,640	2,566	3,990	6,872	6,634	7,783
Stock Dec. 31—							
In bonded warehouses	2	9	39	31	32	48	.....
At smelters	26,364	19,613	11,167	23,201	9,049	4,474	40,659
Total withdrawn	28,493	23,504	14,106	36,466	30,308	18,661	61,928
Apparent consumption	226,969	214,167	270,730	245,884	280,059	340,341	295,370

In considering the consumption of primary spelter there should be borne in mind the rapidly increasing quantity of secondary material, such as zinc skimmings, ashes, hard zinc, and scrap zinc, from which zinc is recovered in the form of spelter, alloy, pigment, chemical, etc., and so used again, thus affecting the consumption of primary spelter. The total quantity of secondary zinc recovered in 1913, so far as there is available record, was 89,528 tons, as compared with 94,111 tons in 1912. For details of the recovery of secondary zinc in 1913 and previous years, see under heading "Secondary zinc" in this chapter.

The consumption of spelter of foreign origin, both that made in this country from foreign ore and that imported directly as spelter, is a matter of much importance to American zinc producers and smelters. The following table gives this consumption of foreign spelter for the period from 1907 to date. A certain portion of the stocks reported by the smelters as on hand at the close of the year must consist of spelter made from foreign ores, and this has not been taken into consideration in the table, but although this would affect the consumption for any single year it will not impair the usefulness of a table covering the length of time here given.

Foreign zinc consumed in United States, 1907–1913, in short tons.

	1907	1908	1909	1910	1911	1912	1913
Supply:							
Produced from foreign ore	26,115	19,675	25,535	16,705	14,905	14,899	9,424
Stocks in bonded warehouse	.....	2	9	39	31	32	48
Imports	1,778	881	9,454	1,960	609	11,115	6,100
Total supply	27,893	20,558	34,998	18,704	15,545	26,046	15,572
Withdrawn:							
Exports from warehouse	9	8	334	4,758	11,276	6,286	6,027
Exports under drawback	1,555	1,234	.....	4,486	3,079	1,219	7,459
Stocks in warehouse	2	9	39	31	32	48	.....
Total	1,566	1,251	373	9,275	14,387	7,553	13,486
Consumption of foreign zinc	26,327	19,307	34,625	9,429	1,158	18,493	2,086

World's consumption of spelter, by countries, 1907–1913, in short tons.

[Stocks disregarded except in the United States.]

	1907	1908	1909	1910	1911	1912	1913
Austria-Hungary	34,171	35,925	36,155	37,258	47,950	51,588	44,533
Belgium	60,627	74,936	71,209	84,326	81,240	85,098	84,216
France	76,720	85,956	73,744	62,059	90,389	90,389	89,286
Germany	192,792	198,580	207,343	196,320	241,734	248,899	255,734
Great Britain	154,653	152,627	171,408	195,989	193,674	204,146	214,508
Holland	4,189	4,189	4,409	4,409	4,409	4,409	4,409
Italy	7,496	9,257	9,039	8,929	11,133	11,795	12,015
Russia	19,290	19,946	20,282	27,447	31,856	30,754	36,707
Spain	5,180	5,512	4,960	4,630	5,291	5,181	6,503
Other countries	13,228	11,020	9,921	13,668	19,621	21,715	23,038
United States	226,969	214,167	270,730	245,884	280,059	340,341	295,370
Total	795,315	812,115	879,200	880,919	1,007,356	1,094,315	1,066,319

World's consumption of spelter, exclusive of secondary zinc, 1898–1913, in short tons.

Year.	Stocks considered.	Stocks disregarded.			
	United States.	United States.	Foreign countries.	Total world's consumption.	United States percentage.
1898	108,199	106,185	422,070	528,255	20.10
1899	124,585	123,688	422,181	545,869	22.66
1900	99,399	102,414	420,858	523,272	19.57
1901	141,697	137,789	424,496	562,285	24.51
1902	152,682	154,138	465,391	619,529	24.88
1903	154,381	157,900	480,162	638,062	24.75
1904	180,911	176,804	520,506	697,400	25.36
1905	200,438	198,835	534,285	733,120	27.13
1906	220,781	221,142	556,882	778,024	28.42
1907	226,969	249,511	568,346	817,857	30.51
1908	214,167	207,423	597,948	805,371	25.75
1909	270,730	262,314	608,472	870,784	30.12
1910	245,884	257,910	635,035	892,945	28.88
1911	280,059	265,908	727,297	993,205	26.77
1912	340,341	335,782	753,974	1,089,756	30.81
1913	295,370	331,507	770,949	1,102,456	30.07

PRICES AND VALUE.

PRICES.

Spelter opened at St. Louis in January at 7.17 cents a pound, the maximum figure of the year. This price held until the middle of the month when, possibly influenced by the importation of foreign spelter of which over 5,000 tons entered in January, it took a sharp drop which continued with the exception of a slight break in the early part of March, until the middle of June when spelter reached 4.97½ cents a pound, the lowest price of the year. A rise then followed which brought spelter to 5.85 cents a pound during the closing week of August. A decline set in which left spelter bringing 5.05 to 5.10 cents per pound at the close of the year. The average price of the metal for the year at St. Louis was 5.6 cents a pound as against 6.9 in 1912. The average price of spelter at New York in 1913 was 5.8 cents, as compared with 7.1 cents in 1912. The average price of spelter at St. Louis is used by the United States Geological Survey in calculating the value of the domestic production of spelter.

The London spelter market opened at £26 5s per long ton (5.7 cents a pound), declined in March to £24 10s per long ton (5.33 cents a pound), rose to £25 15s (5.6 cents a pound) in the latter part of April, then took a big drop to £20 7s 6d (4.43 cents a pound) in July, near the minimum price of the year. Through the latter half of the year the price of spelter fluctuated slightly but remained nearly level, closing at about £21 7s 6d (4.65 cents a pound). The average London price for the year was £22 15s 10d per long ton (4.95 cents a pound).

Zinc dust at New York opened the year at 7⅝ cents a pound and dropped to 7⅜ cents by the early part of February. The price ranged between 7¼ cents and 7⅜ cents a pound throughout the remainder of the year.

The following table, giving highest and lowest prices of spelter in each month for the years 1902–1913, inclusive, is based on figures in the Iron Age prior to 1906. For 1906–1910 the figures are based on the daily quotations in the Engineering and Mining Journal. Beginning with 1911 the figures are taken from the monthly sum-

maries of the Steel and Metal Digest. Prior to 1909 the quotations are from New York City, but for 1909 and after St. Louis prices are taken.

Monthly price range of prime western spelter, 1902–1913.

[Cents per pound.]

Year.	January.		February.		March.		April.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	4.30	4.25	4.25	4.00	4.35	4.20	4.45	4.40
1903	4.90	4.55	5.05	4.97	5.75	5.05	5.75	5.50
1904	5.10	4.90	5.10	4.95	5.20	5.05	5.27	5.20
1905	6.20	6.10	6.15	6.10	6.15	5.87	6.00	5.75
1906	6.70	6.00	6.15	6.05	6.35	6.10	6.15	6.05
1907	6.80	6.70	6.90	6.70	6.90	6.75	6.80	6.55
1908	4.60	4.25	4.85	4.55	4.80	4.60	4.70	4.60
1909	5.20	5.075	5.075	4.525	4.625	4.55	4.95	4.60
1910	6.075	5.65	5.70	5.25	5.625	5.45	5.475	4.90
1911	5.425	5.275	5.55	5.25	5.525	5.30	5.325	5.25
1912	6.50	6.25	6.70	6.40	6.90	6.55	6.75	6.60
1913	7.175	6.60	6.60	6.05	6.25	5.75	5.85	5.40

Year.	May.		June.		July.		August.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	4.65	4.40	4.85	4.80	5.35	5.05	5.50	5.35
1903	5.80	5.75	6.25	5.75	6.25	5.87	6.00	5.80
1904	5.22	4.95	4.95	4.75	4.90	4.87	5.07	4.90
1905	5.70	5.40	5.35	5.25	5.60	5.25	5.80	5.60
1906	6.10	5.90	6.20	6.00	6.05	5.97	6.05	6.02
1907	6.60	6.35	6.45	6.35	6.35	5.85	5.90	5.50
1908	4.675	4.55	4.675	4.45	4.70	4.40	4.775	4.65
1909	5.125	4.875	5.325	5.10	5.325	5.175	5.675	5.325
1910	5.175	4.85	5.075	4.925	5.075	4.95	5.275	5.00
1911	5.25	5.20	5.65	5.20	5.70	5.525	6.05	5.675
1912	6.80	6.65	7.00	6.75	7.10	6.95	7.20	6.80
1913	5.40	5.20	5.15	4.95	5.45	5.15	5.80	5.45

Year.	September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	5.50	5.30	5.50	5.40	5.35	5.10	5.00	4.50
1903	6.10	6.00	6.12	6.00	6.00	5.25	5.25	4.65
1904	5.15	5.07	5.37	5.15	5.80	5.37	6.12	5.80
1905	5.95	5.75	6.15	6.00	6.25	6.10	6.60	6.40
1906	6.35	6.05	6.30	6.15	6.45	6.25	6.65	6.45
1907	5.50	5.05	5.55	5.25	5.25	4.50	4.55	4.10
1908	4.825	4.70	4.875	4.75	5.05	4.875	5.15	5.10
1909	5.80	5.55	6.275	5.775	6.275	6.175	6.225	6.00
1910	5.45	5.225	5.725	5.375	5.90	5.70	5.775	5.275
1911	5.95	5.80	6.25	5.825	6.85	6.25	6.80	6.10
1912	7.50	7.20	7.45	7.30	7.375	7.25	7.25	7.15
1913	5.75	5.425	5.45	5.15	5.225	5.05	5.15	4.975

VALUE.

The production of primary spelter from domestic ores in 1913 was 337,252 short tons, valued at $37,772,224, based on the average St. Louis price, as compared with 323,907 tons, valued at $44,699,166, based on the average St. Louis price in 1912, a gain of 13,345 tons, equal to 4.1 per cent in quantity and a loss of $6,926,942, equal to 15.5 per cent, in value. The production in 1911 was 271,621 tons, valued at $30,964,794; in 1910 it was 252,479 tons, valued at $27,267,732; and in 1909 it was 230,255 tons, valued at $24,864,300.

PRICE CURVES, 1912–13.

The following curves show graphically for the years 1912–13, inclusive, the relations of the weekly average St. Louis price of

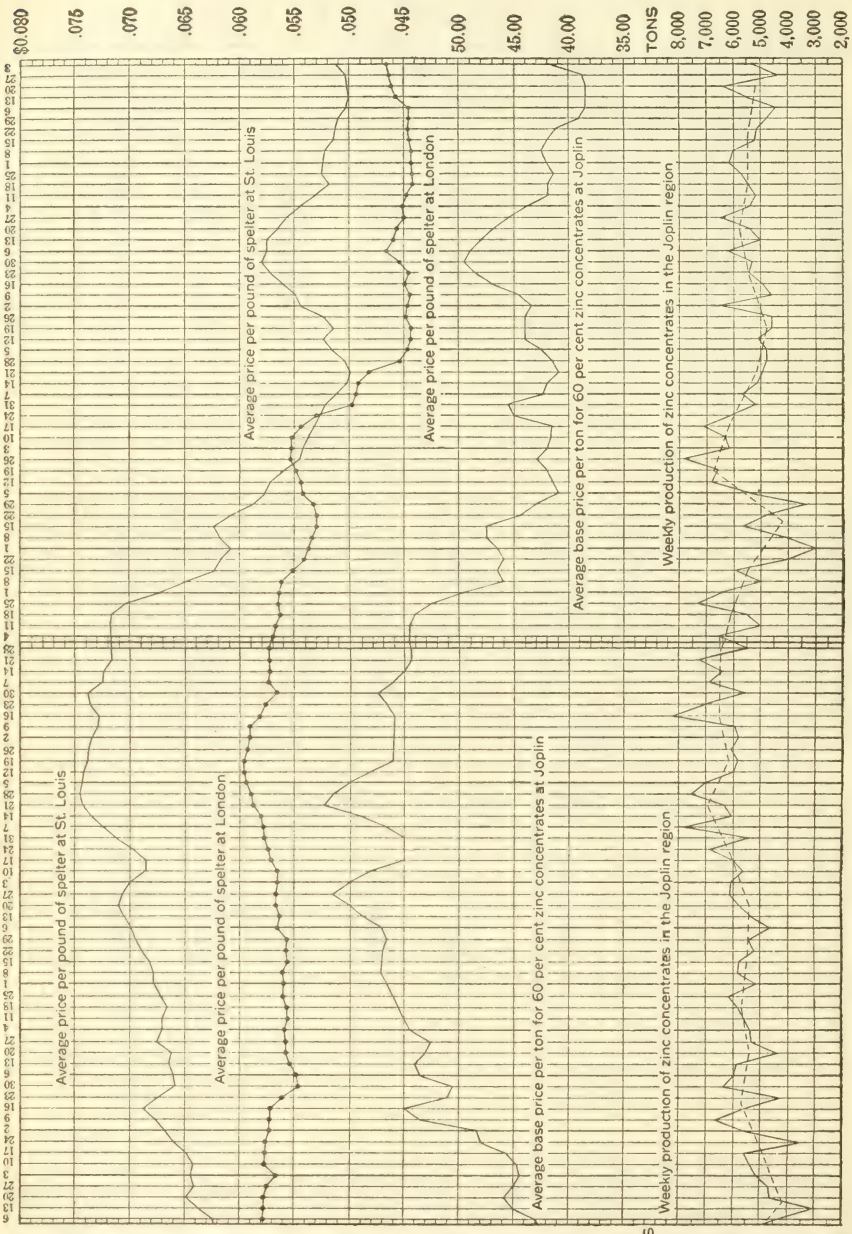

FIGURE 7.—Average weekly price of spelter at London and St. Louis, of 60 per cent zinc concentrates at Joplin, and weekly production of zinc concentrates in the Joplin region, 1912–13.

spelter, the weekly average London price of spelter, the weekly average price of 60 per cent zinc blende concentrates at Joplin, Mo., and

the weekly production, or, to be more exact, the weekly sales of concentrates in the Joplin region as a whole. The price of spelter has been taken from market reports, and the price of zinc blende and the figures of weekly production are those published in the Joplin daily papers. To eliminate the sharp weekly fluctuations and to obtain a curve more easily comparable with the price curves, the weekly sales have been averaged by months, the result being shown by the broken line.

The curve of London price of spelter shows the stabilizing effect of the Zinc Convention. The St. Louis price of spelter shows a minor dependence upon the English market, but a major independence of it. On the whole the price of zinc concentrates at Joplin shows a close correspondence to the price of spelter at St. Louis, though there are various minor discrepancies.

THE ZINC CONVENTION.

The Zinc Convention was formed early in 1909, to remain in force until the close of 1910. It comprised the Zinkhüttenverband m. b. H. and the Société Anonyme des Mines et Fonderies de la Vieille Montagne. The former association embraces 18 zinc smelting firms in Silesia, the Rhine district, Belgium, and Austria. One large firm, Georg von Giesche's Heirs, did not join the association, but acted in concert. The Société Anonyme includes 10 smelters, the majority located in Belgium. The more important English smelters joined the convention late in 1909. The purpose of the convention was to fix beforehand, within certain limits, the production of spelter by its members, and, if the market gave evidence that the consumption was not keeping pace with the production, further to curtail production. The convention has been renewed from period to period and has now been extended until 1916. The following notes are taken from the Engineering and Mining Journal.

The International Zinc Convention, which has been running now for a series of years, has proved to be the most successful attempt of this kind in the history of the industry. On December 18, 1913, the convention was renewed for a period running to April 30, 1916. The new terms are about the same as the old ones, but restriction of production is made a little more prompt in beginning, when such restriction is necessary. Under the old terms, curtailment began after the price had ruled below £22 for four consecutive months, the unsold stocks being in excess of 50,000 tons. The new terms require that the price run below £22 for only two months.

The syndicates comprise all of the German smelters, the most important of the Austrian, and nearly all of the French and Belgian, besides a considerable proportion of British. The International Convention is made up of groups of syndicates, the most important being the German syndicate, which is known as Group A. The French smelters are embraced for the most part in Group B, while the British are allied in Group C. The German syndicate, Group A, comprises all of the German smelters, although the adherence of Giesche's Erben, a very important Silesian company, is only partial, i. e., that company reserves a certain independence.

The position of these groups is different. The British and French are committed only to the joint regulation of production. The German, on the other hand, is a tightly bound syndicate, with agreements respecting production and price, for the common sale of its product through certain agencies and a joint accounting bureau.

In 1911 the European production of spelter was 633,000 metric tons; of members of the International Convention 550,000; of the German syndicate 325,000. In 1912, the respective figures were 661,000, 580,000, and 360,000. It appears therefore that only a little more than 50 per cent of the European production is absolutely controlled as to marketing. The British and French groups are free to sell as they please and do so, but in certain circumstances are bound to restrict their production. This apparently throws the chief burden of carrying unsold accumulations upon the German syndicate.

SUMMARY.

The larger items of the world's spelter industry for the last six years are given below.

Summary of spelter statistics for 1908–1913.

	1908	1909	1910	1911	1912	1913
Production of spelter by United States	210,424	255,760	269,184	286,526	338,806	346,676
Consumption of spelter by United States (stocks considered)	214,167	270,730	245,884	280,059	340,341	295,370
Production of spelter by world	796,896	854,066	893,046	986,061	1,070,045	1,093,635
Consumption of spelter by world (stocks considered in United States)	812,115	879,200	880,919	1,007,356	1,094,315	1,066,319
Excess of world production over consumption	.....	.....	12,127	.....	.....	27,316
Excess of world consumption over production	15,219	25,134	.....	21,295	24,270	.....
United States percentage of world production	26.4	29.9	30.1	29.1	31.7	31.7
United States percentage of world consumption (stocks considered in United States)	26.4	30.8	27.9	27.8	31.0	27.7
Rank of United States in spelter production	Second.	First.	First.	First.	First.	First.
Rank of United States in spelter consumption	First.	First.	First.	First.	First.	First.

SURVEY PUBLICATIONS ON LEAD AND ZINC.

The following list includes the more important publications on lead and zinc published by the United States Geological Survey. These publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. The publications marked "exhausted" are no longer available for distribution but may be seen at the larger libraries of the country.

Adams, G. I., Zinc and lead deposits of northern Arkansas: Bull. 213, pp. 187–196, 1903. 25c.

Adams, G. I., and others, Zinc and lead deposits of northern Arkansas: Prof. Paper 24, 118 pp., 1904. 40c.

Bain, H. F., Lead and zinc deposits of Illinois: Bull. 225, pp. 202–207, 1904. 35c.

——— Lead and zinc resources of the United States: Bull. 260, pp. 251–273, 1905. Exhausted.

——— A Nevada zinc deposit: Bull. 285, pp. 166–169, 1906. Exhausted.

——— Zinc and lead deposits of northwestern Illinois: Bull. 246, 56 pp., 1905. 15c.

——— Zinc and lead deposits of the upper Mississippi Valley: Bull. 294, 155 pp., 1906. 75c.

——— Zinc and lead ores in 1905: Mineral Resources, 1905, pp. 379–392, 1906.

Bain, H. F., Van Hise, C. R., and Adams, G. I., preliminary report on the lead and zinc deposits of the Ozark region: Twenty-second Ann. Rept., pt. 2, pp. 23–228, 1902. $2.25.

Bancroft, Howland, Reconnaissance of the ore deposits in northern Yuma County, Ariz.: Bull. 451, 130 pp., 1911.

——— Lead and zinc deposits of the Metaline mining district, northeastern Washington: Bull. 470, pp. 188–200, 1911.

———The ore deposits of northeastern Washington, with report on the Republic mining district, by Waldemar Lindgren and Howland Bancroft: Bull. 550, 215 pp., 1914.

Becker, G. F., Geology of the Comstock lode and the Washoe district, with atlas: Mon. 3, 422 pp., 1882. $11.

Brooks, A. H., Geologic features of Alaskan metaliferous lodes: Bull. 480, pp. 43–93, 1911.

BOUTWELL, J. M., Economic geology of the Bingham mining district, Utah: Prof. Paper 38, pp. 73–385, 1905. $1.10.
BOUTWELL, J. M., and WOOLSEY, L. H., Geology and ore deposits of the Park City district, Utah: Prof. Paper 77, 231 pp., 1912.
BUTLER, B. S., and DUNLOP, J. P., Silver, copper, lead, and zinc in the Central States in 1913 (mines report): Mineral Resources, 1913, pt. 1, pp. 81–171,[1] 1914.
CALKINS, F. C., and JONES, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: Bull. 540, pp. 167–211, 1914.
CALKINS, F. C., and MACDONALD, D. F., A geologic reconnaissance in northern Idaho and northwestern Montana: Bull. 384, 112 pp., 1909.
CLERC, F. L., The mining and metallurgy of lead and zinc in the United States: Mineral Resources, 1882, pp. 358–386, 1883. 50c.
CROSS, WHITMAN, HOWE, ERNEST, and RANSOME, F. L., Geol. Atlas, Silverton folio (No. 120), 1905. 5c.
CROSS, WHITMAN, SPENCER, A. C., and RANSOME, F. L., Geol. Atlas, Rico folio (No. 130), 1905. 5c.
CROSS, WHITMAN, and HOLE, A. D., Geol. Atlas, Engineer Mountain folio (No. 171), 1910. 5c.
CURTIS, J. S., Silver-lead deposits of Eureka, Nev.: Mon. 7, 200 pp., 1884. $1.20.
ELLIS, E. E., Zinc and lead mines near Dodgeville, Wis.: Bull. 260, pp. 311–315, 1905. Exhausted.
EMMONS, S. F., Geology and mining industry of Leadville, Colo., with atlas: Mon. 12, 870 pp., 1886. Exhausted.
——— Abstract of report on geology and mining district of Leadville, Lake County, Colo.: Second Ann. Rept., pp. 201–290, 1882. $2.
——— Economic geology of the Mercur mining district, Utah: Sixteenth Ann. Rept., pt. 2, pp. 349–369, 1895. $1.25.
——— The mines of Custer County, Colo.: Seventeenth Ann. Rept., pt. 2, pp. 411–472, 1896. $2.35.
EMMONS, S. F., and IRVING, J. D., Downtown district of Leadville, Colo.: Bull. 320, 72 pp., 1907.
EMMONS, W. H., Some ore deposits in Maine and the Milan mine, New Hampshire: Bull. 432, 62 pp., 1910.
EMMONS, W. H., and LARSEN, E. S., A preliminary report on the geology and ore deposits of Creede, Colo.: Bull. 530, pp. 42–65, 1913.
GRANT, U. S., Zinc and lead deposits of southwestern Wisconsin: Bull. 260, pp. 304–310, 1905. Exhausted.
GRANT, U. S., and BURCHARD, E. F., Geol. Atlas, Lancaster-Mineral Point folio (No. 145), 1907. Exhausted.
HAGUE, ARNOLD, Geology of the Eureka district, Nevada: Mon. 20, 419 pp., 1892. $5.25.
HAHN, O. H., The smelting of argentiferous lead ores in the far West: Mineral Resources, 1882, pp. 324–345, 1883. 50c.
HILL, J. M., Mining districts of the western United States: Bull. 507, 309 pp., 1912.
——— The Yellow Pine mining district, Clark County, Nev.: Bull. 540, pp. 223–273, 1914.
HOFFMAN, H. O., Recent improvements in desilverizing lead in the United States: Mineral Resources, 1883–84, pp. 462–473, 1885. 60c.
HUNTER, J. F., Some cerusite deposits in Custer County, Colo.: Bull. 580, pp. 25–37, 1914.
ILES, M. W., Lead slags: Mineral Resources, 1883–84, pp. 440–462, 1885. 60c.
IRVING J. D., Ore deposits of the northern Black Hills: Bull. 260, pp. 50–77, 1905. Exhausted.
——— Ore deposits in the vicinity of Lake City, Colo.: Bull. 260, pp. 78–84, 1905. Exhausted.
IRVING, J. D., and BANCROFT, HOWLAND, Geology and ore deposits near Lake City, Colo.: Bull. 478, 128 pp., 1911.
IRVING, J. D., EMMONS, S. F., and Jaggar, T. A., jr., Economic resources of the northern Black Hills: Prof. Paper 26, 222 pp., 1904. 55c.
KEITH, ARTHUR, Geol. Atlas, Maynardville folio (No. 75), 1901. 5c.
——— Recent zinc mining in East Tennessee: Bull. 225, pp. 208–213, 1904. 35c.
KNOPF, ADOLPH, The Darwin silver-lead mining district, California: Bull. 580, pp. 1–18, 1914.
——— Ore deposits of the Helena Mining region, Montana: Bull. 527, 143 pp., 1913.
——— Mineral resources of the Inyo and White Mountains, California: Bull. 540, pp. 81–120, 1914.

[1] Earlier volumes of the Mineral Resources of the United States also contain discussions relating to the lead and zinc industries of the United States.

LINDGREN, WALDEMAR, The mining districts of the Idaho Basin and the Boise Ridge, Idaho: Eighteenth Ann. Rept., pt. 3, pp. 625–736, 1898. $2.15.
——— The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: Twentieth Ann. Rept. pt. 3, pp. 75–256, 1900. $1.50.
——— A geological reconnaissance across the Bitterroot Range and Clearwater Mountains in Montana and Idaho: Prof. Paper 27, 123 pp., 1904. 30c.
——— The Tres Hermanas mining district, New Mexico: Bull. 380, pp. 123–128, 1909. 40c.
——— Resources of the United States in gold, silver, copper, lead, and zinc.: Bull. 394, pp. 114–156, 1909. 40c.
LINDGREN, WALDEMAR, and GRATON, L. C., Mineral deposits of New Mexico: Bull. 285, pp. 74–86, 1906. Exhausted.
LINDGREN, WALDEMAR, GRATON, L. C., and GORDON, C. H., The ore deposits of New Mexico: Prof. Paper 68, 361 pp., 1910. Paper, 80c.; buckram, $1.
MACDONALD, D. F., Economic features of northern Idaho and northwestern Montana: Bull. 285, pp. 41–52, 1906. Exhausted.
MCCASKEY, H. D., Gold, silver, copper, lead, and zinc in the Eastern States (mines report): Mineral Resources, 1913, pt. 1, pp. 173–196, 1914.
MCCASKEY, H. D., and others: Gold, silver, copper, lead, and zinc in the Western States in 1913 (mines report): Mineral Resources, 1913, pt. 1, 1914.
PEPPERBERG, L. J., Notes on the mineral deposits of the Bearpaw Mountains, Montana: Bull. 430, pp. 135–146, 1910.
RANSOME, F. L., Report on the economic geology of the Silverton quadrangle, Colorado: Bull. 182, 265 pp., 1901. 50c.
——— The ore deposits of the Rico Mountains, Colorado: Twenty-second Ann. Rept., pt. 2, pp. 229–398, 1902. $2.25.
——— Geology and ore deposits of the Breckenridge district, Colorado: Prof. Paper 75, 187 pp., 1911.
RANSOME, F. L., and CALKINS, F. C., Geology and ore deposits of the Cœur d'Alene district, Idaho: Prof. Paper 62, 203 pp., 1908. 85c.
RICHARDS, R. W., Notes on lead and copper deposits in the Bear River Range, Idaho and Utah: Bull. 470, pp. 177–187, 1911.
SCHRADER, F. C., Mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: Bull. 340, pp. 53–84, 1908. 30c.
——— The mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: Bull. 397, 226 pp., 1909. 35c.
SIEBENTHAL, C. E., Mineral resources of northeastern Oklahoma: Bull. 340, pp. 187–228, 1908. 30c.
——— Lead: Mineral Resources, 1913, pt. 1, 1914.
——— Zinc: Mineral Resources, 1913, pt. 1, 1914.
SMITH, G. O., Note on a mineral prospect in Maine: Bull. 315, pp. 118–119, 1907. 50c.
SMITH, W. S. T., Lead and zinc deposits of the Joplin district, Missouri-Kansas. Bull. 213, pp. 197–204, 1903. 25c.
SMITH, W. S. T., and SIEBENTHAL, C. E., Geol. Atlas, Joplin district folio (No. 148), 1907. 50c.
SPENCER, A. C., The Mine Hill and Sterling Hill zinc deposits of Sussex County, N. J.: New Jersey Geol. Survey, Ann. Rept. for 1908, pp. 25–52, 1909.
SPENCER, A. C., SALISBURY, R. D., and KÜMMEL, H. B., Geol. Atlas, Franklin Furnace folio (No. 161), 1908. 5c.
SPURR, J. E., Geology of the Aspen mining district, Colorado, with atlas: Mon. 31, 260 pp., 1898. $3.60.
——— The ore deposits of Monte Cristo, Wash.: Twenty-second Ann. Rept., pt. 2, pp. 777–866, 1902. $2.25.
——— Descriptive geology of Nevada south of the fortieth parallel and adjacent portions of California: Bull. 208, 229 pp., 1903. 25c.
SPURR, J. E., and GARREY, G. H., Preliminary report on the ore deposits of the Georgetown mining district, Colorado: Bull. 260, pp. 99–120, 1905. Exhausted.
——— The Idaho Springs mining district, Colorado: Bull. 285, pp. 35–40, 1906. Exhausted.
——— Economic geology of the Georgetown quadrangle, together with the Empire district, Colorado, with general geology by S. H. Ball: Prof. Paper 63, 422 pp., 1908. $1.75.
TOWER, G. W., and SMITH, G. O., Geology and mining industry of the Tintic district, Utah: Nineteenth Ann. Rept., pt. 3, pp. 601–767, 1899. $2.25.

TOWER, G. W., SMITH, G. O., and EMMONS, S. F., Geol. Atlas, Tintic special folio (No. 65), 1900. 5c.
ULRICH, E. O., and SMITH, W. S. T., The Lead, zinc, and fluorspar deposits of western Kentucky: Prof. Paper 36, 218 pp., 1905.
UMPLEBY, J. B., Geology and ore deposits of Lemhi County, Idaho: Bull. 528, 182 pp., 1913.
——— Some ore deposits in Northwestern Custer County, Idaho: Bull. 539, 104 pp., 1913.
——— The lead-silver deposits of the Dome district, Idaho: Bull. 540, pp. 212–222, 1914.
WEED, W. H., Geol. Atlas, Fort Benton folio (No. 56), 1899. 5c.
——— Geol. Atlas, Little Belt Mountains folio (No. 55), 1899. 5c.
——— Geology of the Little Belt Mountains, Montana, with notes on the mineral deposits of the Neihart, Barker, Yogo, and other districts: Twentieth Ann. Rept., pt. 3, pp. 271–461, 1900. $1.50.
WEED, W. H., and BARRELL, JOSEPH, Geology and ore deposits of the Elkhorn mining district, Jefferson County, Mont.: Twenty-second Ann. Rept., pt. 2, pp. 399–549, 1901. $2.25.
WEED, W. H., and PIRSSON, L. V., Geology of the Castle Mountains mining district: Bull. 139, 164 pp., 1896. 15c.
WINSLOW, A., The disseminated lead ores of southeastern Missouri: Bull. 132, 31 pp., 1896. 5c.
WOLFF, J. E., Zinc and manganese deposits of Franklin Furnace, N. J.: Bull. 213, pp. 214–217, 1903. 25c.

CADMIUM.

By C. E. Siebenthal.

INTRODUCTION.

A brief account of the production, resources, metallurgy, and uses of cadmium was given as a chapter in Mineral Resources for 1908, and the reader is referred to that paper for further information.

The chief output of cadmium comes from the zinc-producing regions of Silesia, where it is recovered as a by-product in the distillation of zinc. Recently in England a little cadmium has been recovered in the purification of the solution of zinc sulphate in the manufacture of lithopone, and the same has been done in the United States for several years.

PRODUCTION.

Cadmium in metallic form has been recovered in the United States since 1907 by a single producer and since the latter part of 1910 by two producers. A considerable quantity of the pigment, cadmium sulphide, was also produced in 1913. No authoritative statement of the method of recovering metallic cadmium has yet been made. The metallurgical method employed abroad has generally been fractional distillation of zinc ores. Cadmium has also been recovered as a by-product in the manufacture of lithopone, as noted above. Among the possible sources of cadmium in a general chemical works would be the slime left in the production of zinc chloride from zinc scrap, skimmings, etc., or from low-grade roasted zinc ores. As dilute hydrochloric acid dissolves zinc in preference to cadmium, the cadmium content of the zinc scrap, skimmings, etc., is left behind in the slimes. From these slimes the cadmium may be recovered by distillation, by electrolysis, or by purely chemical methods.

Bain [1] noted the presence of cadmium in the zinc ores of the Leadville and Kokomo districts of Colorado, and Guyard [2] gives analyses of flue, chamber, and bag-house dust from Leadville, which show small percentages of cadmium in each. At the time Guyard's analyses were made the ores being smelted at Leadville were mostly carbonates, with little or no sulphides and only a trace of zinc. In the extensive zinc-lead sulphide deposits developed in later years the cadmium content, as shown by Bain, is much higher, so that the bag-house dust from Leadville ores must now show considerably higher proportions of cadmium. In 1908, W. R. Ingalls stated [3]

[1] Bain, H. F., U. S. Geol. Survey Mineral Resources, 1905, p. 384, 1906.
[2] Guyard, Anthony. Geology and mining industry of Leadville, Colo.: U. S. Geol. Survey Mon. 12, Appendix C, pp. 712, 715, 717, 1886.
[3] Mineral Industry, vol. 17, p. 126, 1908.

that noteworthy quantities of cadmium occur in "fume" from lead smelting furnaces, collected by bag filtration in Colorado, and that the utilization of this material as a source of cadmium had been considered, though negatived on account of lack of market for the metal.

In smelting such ores the cadmium will distill over from the blast furnaces to the bag house, where it will be caught with arsenic, lead, and antimony. When the burnt fume from the bag house is charged back into the blast furnaces most of the lead and antimony will be recovered in metallic form, but the arsenic and cadmium will again go over to the bag house. In time the fume will be very much enriched in cadmium and arsenic. The difference in temperature at which arsenic and cadmium volatilize allows an easy separation of these metals, and after separation the cadmium residue can be reduced to metallic form without difficulty. The cadmium may be recovered by distillation or by an electrolytic process.

Inasmuch as the production is limited to two firms, the quantity and value of the output can not be given. The local production in 1907 was nearly sufficient to supply the domestic demand—a fact shown by the small imports for that year—but the next year the quantity of cadmium imported was about doubled, and in 1909–1912 the imports of cadmium were back at the old figures which obtained before the beginning of the production of cadmium in the United States. The domestic production was considerably larger in 1913 than in any previous year and as a result the imports of cadmium were the smallest since 1903.

PRODUCTION IN GERMANY.

The following table gives the production of cadmium in Upper Silesia from 1882 to 1912, inclusive:

Quantity and value of cadmium produced in Germany, 1882–1912.[a]

Year.	Quantity.	Value.	Average price per pound.	Year.	Quantity.	Value.	Average price per pound.
	Pounds.				*Pounds.*		
1882	7,762			1898	32,954	$29,666.70	$0.90
1883	5,333			1899	21,693	15,544,26	.72
1884	6,118			1900	29,835	19,524.81	.65
1885	7,222			1901	28,977	19,754.71	.68
1886	10,944	$8,710.56	$0.80	1902	27,833	15,132.00	.54
1887	16,140	11,542.29	.72	1903	36,519	19,242.06	.53
1888	10,573	5,439.49	.51	1904	55,655	32,882.32	.59
1889	11,327	4,621.71	.41	1905	54,163	35,240.18	.65
1890	9,167	3,477.18	.38	1906	47,368	36,083.89	.76
1891	6,281	2,423.32	.39	1907	72,639	60,757.35	.84
1892	7,055	2,713.20	.38	1908	72,741	48,590.21	.67
1893	11,651	5,198.87	.45	1909	81,982	46,777.16	.57
1894	15,095	8,393.31	.56	9110	90,516	39,309.51	.43
1895	15,095	9,052.04	.60	1911	93,861	53,372.45	.57
1896	23,514	19,453.64	.83	1912	94,262	63,507.26	.67
1897	34,231	42,037.23	1.23				

[a] Recalculated to pounds and dollars from Statistik des Oberschlesischen Berg-und Hüttenmännischen Vereins, as quoted by Jensch, from Vierteljahreshefte zur Statistik des Deutschen Reichs and from Statistisches Jahrbuch für den Preussischen Staat.

IMPORTS.

Cadmium is imported into the United States as metallic stick cadmium and as the pigment, cadmium sulphide (CdS), known as "cadmium yellow." The former is free of duty; the latter is dutiable at 30 per cent ad valorem. The value of the imports for consumption of metallic cadmium for 1903 to 1913, inclusive, is given in the table below, which is taken from the records of the Bureau of Foreign and Domestic Commerce. The quantities are not there recorded previous to July, 1909, and for the period preceding that time they have been computed by dividing the values of the imports by the average price of cadmium for the corresponding year in Germany, from which country the cadmium was imported. The quantity of cadmium imported as a pigment and the value thereof are not kept separately by the Bureau of Foreign and Domestic Commerce.

Cadmium imported for consumption into the United States, 1903–1913, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	[a] 8,679	$4,565	1909 first half	[a] 6,659	$4,559
1904	[a] 7,655	4,524	1909 second half	2,203	
1905	[a] 8,138	5,298	1910	4,060	2,295
1906	[a] 13,808	10,522	1911	5,367	3,870
1907	[a] 1,953	1,633	1912	5,250	3,764
1908	[a] 3,567	2,390	1913	1,656	1,232

[a] Prior to July, 1909, the quantities are computed as noted above.

PRICES.

The domestic quotations on cadmium in 1913 ranged from 75 to 85 cents a pound, and the average price for the year, as based on sales, was a little more than 75 cents a pound.

According to Paul Speier, of Breslau, Germany, the price of 99½ per cent cadmium sticks in the first half of 1913 fluctuated between 725 marks and 750 marks per 100 kilograms (78 cents to 81 cents a pound) f. o. b. cars at the works. During the latter half of the year the price was steady at 750 marks per 100 kilograms (81 cents a pound).

GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA IN 1913.

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

During the calendar year 1913 there were produced in Arizona, gold, silver, copper, lead, and zinc contained in bullion, ore of shipping grade, and concentrates having a total value of $70,875,027. This output was made by 402 deep mine and 36 placer producers, as against 394 deep mine and 51 placer producers whose output in 1912 was valued at $67,050,784. The increase of $3,824,243 in total value was due mainly to increased production of copper, though there were smaller increases in the values for other metals, except zinc. The increase in value for 1913 was as follows: Gold from $3,762,210 in 1912 to $4,023,911, an increase of $261,701 in 1913; silver, from $2,146,588 to $2,384,647, an increase of $238,059; copper, from $60,231,377 to $63,228,127, an increase of $2,996,750; lead, from $306,290 to $710,370, an increase of $404,080 in 1913. Zinc, although increasing in quantity produced, declined in value from $604,319 in 1912 to $527,972, a decrease of $76,347 in 1913. Statistics showing the total metallic yield since 1904, with increase and decrease for 1913, are given in the following table:

Number of producers, quantity of ore sold or treated in Arizona in 1904–1913, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	117	2,305,938	$3,478,532	2,314,940	199,481,044	1,779,967	.....	$29,816,840
1905	134	2,678,059	2,799,214	2,605,712	228,418,679	4,940,910	140,000	40,246,861
1906	171	3,585,089	2,964,683	3,026,438	266,831,864	5,638,735	.....	56,812,355
1907	437	3,567,133	2,617,313	2,511,897	254,879,489	4,660,684	228,490	55,511,560
1908	310	3,696,938	2,431,977	2,808,450	285,858,133	3,008,583	678,446	41,811,975
1909	268	4,029,955	2,737,500	2,601,161	303,899,461	3,098,083	5,977,237	44,053,023
1910	373	3,914,969	3,149,366	2,566,528	297,491,151	2,696,998	5,484,899	42,731,519
1911	397	4,567,139	3,430,503	3,276,571	306,141,538	10,274,552	4,562,984	44,157,223
1912	445	6,840,082	3,762,210	3,490,387	365,038,649	6,806,443	8,758,243	67,050,784
1913	438	7,931,862	4,023,911	3,948,091	407,923,402	16,144,772	9,428,067	70,875,027
Increase (+) in 1913		+1,091,780	+261,701	+457,704	+42,884,753	+9,338,329	+669,824	+3,824,243

[a] Includes placer production.

ORE PRODUCTION IN 1913.

Ore mined in Arizona aggregated 7,931,862 tons in 1913, an increase of 1,091,780 tons over the output of 1912. The total average value per ton decreased from $9.80 to $8.93, and the gold and silver value from 86 cents to 80 cents in 1913. In the counties where immense tonnages are mined yearly, the general total average value of the ore shows very little change, provided no radical changes are met with in the average prices of the metals. The increase in ore production was mainly in copper ores, siliceous ores, lead ores, lead-zinc ores, and copper-lead ores. Dry or siliceous ores increased from 250,142 tons in 1912 to 297,288 tons in 1913. This classification includes 210,228 tons of siliceous gold ores, averaging per ton $11.82 in gold and 0.33 ounce of silver. These ores were principally from Mohave, Yavapai, Maricopa, and Santa Cruz counties. Gold and silver ores, dry or siliceous in character, aggregated 1,261 tons and averaged $6.67 in gold and 16.91 ounces of silver, 2.85 pounds of copper, and 1.45 pounds of lead per ton, and were produced chiefly in Greenlee County. The siliceous silver ores produced in 1913 aggregated 32,216 tons, averaging per ton $1.18 in gold, 7.27 ounces of silver, 0.43 pound of copper, and 10.22 pounds of lead. These ores were produced principally in Cochise County. The copper ore mined by 280 producers aggregated 7,553,935 tons, against 6,542,154 tons mined by 199 producers in 1912. Of the copper ore mined in 1913, the total included the low-grade schist and "porphyry" copper ores at Ray and in the Globe district, where 3,427,961 tons were mined. To this may be added 1,494,447 tons of milling ores mined and treated for copper in Greenlee County, which embraces Clifton and Morenci camps, making the total output of schist and porphyry ores aggregate 4,922,408 tons, with a yield of 138,471,483 pounds, or 33.94 per cent of Arizona's total yield of copper. All of the lower-grade copper ores at Ray and Miami and in Greenlee County were concentrated and the concentrates were smelted. There were mined and directly smelted 2,327,438 tons of copper ores, about half oxidized and half sulphides, averaging 53 cents in gold and 1.13 ounces of silver, and 5.46 per cent of copper, with a total gross value of $18.13 per ton. The oxidized copper ores, 1,144,459 tons in quantity, averaged per ton 34 cents in gold and 0.97 ounce of silver, and 5.54 per cent of copper. The lead ore directly smelted increased from 20,696 tons mined in 1912 to 26,203 tons in 1913. Of this kind of ore, the sulphides predominated and aggregated 19,975 tons, averaging per ton $1.51 in gold and 19.35 ounces of silver, and 0.71 per cent of copper, and 17.84 per cent of lead, with a total value of $31.11 per ton. The oxidized ores of lead, mostly iron oxides with lead carbonates, aggregated 6,228 tons and averaged per ton 87 cents in gold and 15.69 ounces of silver, and 2.72 per cent of copper, and 18.14 per cent of lead, with a value of $34.75 per ton. The output of zinc ores of shipping grade increased from 4,264 tons mined in 1912 to 5,878 tons mined in 1913. The oxidized zinc ores were produced in the largest quantities, aggregating 4,413 tons, from which was recovered an average of 24.34 per cent of zinc (spelter). The sulphide zinc ores aggregated 1,465 tons and yielded 34.34 per cent of zinc (spelter). Lead-zinc ores, all sulphide, aggregated 214 tons in 1913, and averaged per ton 85 cents in gold and 22.39 ounces of silver, 0.88 per cent of cop-

per, 16.85 per cent of lead, and 27.39 per cent of zinc (spelter). The production of copper-lead ores increased from 315 tons in 1912 to 4,834 tons in 1913. The oxidized copper-lead ore, of which 4,699 tons were produced, predominated, averaging per ton $1.26 in gold and 5.89 ounces of silver, and 3.13 per cent of copper, and 9.20 per cent of lead. The sulphide copper-lead ores aggregating 135 tons averaged per ton $6.72 in gold and 43.53 ounces of silver, and 6.44 per cent of copper, and 12.23 per cent of lead.

The total tonnage of ore produced, based on the quantity of crude ore mined and sold or treated in Arizona in 1913 is shown in the following table:

Output of ore and production of metals in Arizona in 1913, by kinds of ore.

Source of production.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	36	.....	1,484.67	270	.....	.....	.....
Dry or siliceous ore	253	297,288	123,763.86	392,413	983,400	679,415	.....
Copper ore	280	7,553,935	64,437.34	2,885,115	405,963,634	9,206	.....
Lead ore	70	28,551	2,340.62	498,457	630,815	9,609,597	.....
Zinc ore	9	14,554	805.35	25,153	2,350	136,071	5,020,038
Copper-lead ore	10	4,834	329.43	33,565	311,835	897,249	.....
Lead-zinc ore	2	29,700	1,379.17	111,715	20,326	4,812,396	4,350,869
Copper-zinc ore	1	3,000	116.25	1,403	11,042	838	57,160
Total	.....	7,931,862	194,656.69	3,948,091	407,923,402	16,144,772	9,428,067

Subdivision of tonnage of ore sold or treated in Arizona in 1913, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Copper-zinc ore.	Total.
Cochise	85,470	1,453,599	20,690	108	7	.....	.....	1,559,874
Coconino	.....	216	.....	.....	.....	.....	.....	216
Gila	27	1,500,513	1,080	.....	.....	.....	.....	1,501,620
Greenlee	1,093	1,733,889	.....	.....	.....	.....	.....	1,734,982
Maricopa	34,072	192	.....	.....	.....	.....	.....	34,264
Mohave	161,441	2,234	3,064	10,014	.....	29,486	.....	206,239
Pima	75	12,660	733	4,374	4,524	.....	.....	22,366
Pinal	326	2,378,482	9	.....	6	.....	.....	2,378,823
Santa Cruz	544	20,837	1,011	.....	270	.....	.....	22,662
Yavapai	2,918	441,011	431	58	27	214	3,000	447,659
Yuma	11,322	10,302	1,533	.....	.....	.....	.....	23,157
Total	[a] 297,288	7,553,935	28,551	14,554	4,834	29,700	3,000	7,931,862
Value per ton in gold and silver	$9.40	$0.41	$12.24	$2.19	$5.60	$3.23	$1.08	$0.80

[a] Includes 210,228 tons of gold ore, 1,261 tons of gold and silver ore, 32,216 tons of silver ore, and 53,583 tons chiefly of pyritic iron ore.

GOLD.

The recoverable gold production of Arizona in 1913 was 194,656.69 ounces valued at $4,023,911, an increase of $261,701. Of this output $30,691 came from placers, $2,558,426 from dry or siliceous ore, and $1,332,038 from copper ore. The largest production of gold was from Mohave County, $1,874,547 in 1913, against $1,899,131 in 1912. Gold from ores treated in mills by amalgamation amounted to $302,120 and from ores treated by cyanidation to $2,007,704. Concentrates contained $308,090 and ores shipped to smelters, $1,362,504. The chief sources of gold were the siliceous ores from the San Francisco district of Mohave County and the copper ores of Warren district of Cochise County. The gold output of Maricopa County in 1913 increased $299,724 over 1912, while that of Cochise County decreased $102,220.

Source of gold production in Arizona, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper lead ore.	Lead-zinc ore.	Copper zinc ore.	Total.
Cochise	.....	2,946.57	34,990.03	1,155.00	.....	.....	.....	.....	39,091.60
Gila	.....	57.76	2,156.27	21.67	.....	.....	.....	.....	2,235.70
Greenlee	9.77	275.25	554.43	.....	.....	.....	.....	.....	839.45
Maricopa	51.66	28,753.38	4.59	.....	.....	.....	.....	.....	28,809.63
Mohave	.....	87,383.58	37.88	1,086.65	802.78	.....	1,370.32	.....	90,681.21
Pima	405.91	111.08	46.29	13.93	.....	7.40	.....	.....	584.61
Pinal	53.50	211.06	3,089.52	.....	.....	1.16	.....	.....	3,355.24
Santa Cruz	.....	809.71	114.69	37.73	.....	318.74	.....	.....	1,280.87
Yavapai	493.91	1,560.42	22,813.90	22.30	2.57	2.13	8.85	116.25	25,020.33
Yuma	469.92	1,655.05	629.74	3.34	.....	.....	.....	.....	2,758.05
Total	1,484.67	[a]123,763.86	64,437.34	2,340.62	805.35	329.43	1,379.17	116.25	194,656.69

[a] Includes 120,351.91 ounces from gold ore, 406.82 ounces from gold and silver ore, 1,858.40 ounces from silver ore, and 1,146.74 ounces chiefly from pyritic iron ore.

SILVER.

The recoverable output of silver from Arizona ores increased from 3,490,387 ounces, valued at $2,146,588 in 1912, to 3,948,091 ounces, valued at $2,384,647, in 1913. Of this output, 2,885,115 ounces came from copper ore, 392,413 ounces from dry or siliceous ore, and 498,457 ounces from lead ore. Bullion recovered from gold and silver ores, principally by cyanidation, yielded 72,899 ounces of silver in 1913; concentrates produced 393,553 ounces; and crude ore shipped to smelters contained 3,403,008 ounces. Cochise County mines produced 2,127,191 ounces of silver in 1913, against 1,962,644 ounces in 1912, and Yavapai County 854,049 ounces in 1913, against 748,872 ounces in 1912.

Source of silver production in Arizona, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Copper-zinc. ore.	Total.
Cochise	.....	281,278	1,568,630	277,252	.....	31	.....	.....	2,127,191
Coconino	.....	.....	237	.....	.....	.....	.....	.....	237
Gila	.....	595	343,258	4,345	.....	.....	.....	.....	348,198
Greenlee	2	16,301	19,756	.....	.....	.....	.....	.....	36,059
Maricopa	3	16,649	14,932	.....	.....	.....	.....	.....	31,584
Mohave	.....	45,609	5,196	64,889	24,084	.....	106,924	.....	246,702
Pima	66	865	22,886	15,646	2	25,012	.....	.....	64,477
Pinal	8	509	157,463	1,850	.....	2,019	.....	.....	161,849
Santa Cruz	.....	5,792	24,959	23,063	.....	6,020	.....	.....	59,834
Yavapai	103	18,533	722,894	104,775	1,067	483	4,791	1,403	854,049
Yuma	88	6,282	4,904	6,637	.....	.....	.....	.....	17,911
Total	270	[a]392,413	2,885,115	498,457	25,153	33,565	111,715	1,403	3,948,091

[a] Includes 69,396 ounces from gold ore, 21,329 ounces from gold and silver ore, 234,056 ounces from silver ore, and 67,632 ounces chiefly from pyritic iron ore.

COPPER.

The copper produced from Arizona ores increased from 365,038,649 pounds, valued at $60,231,377, in 1912, to 407,923,402 pounds, valued at $63,228,127, in 1913. Thus in 1913 Arizona continued to rank first among the copper-producing States. Concentrates recovered from ores treated at concentration plants yielded 147,327,295 pounds at the output, and crude ore shipped to the smelters produced 255,867,509 pounds. Cochise County, which includes the Warren or Bisbee district, produced 165,103,854 pounds of copper, against 147,654,661 pounds in 1912. Greenlee County, embracing Copper Mountain and Greenlee districts of the Clifton-Morenci region, produced 69,466,560 pounds of copper, against 76,848,299 pounds in 1912. Yavapai County, including the Verde district, pro-

duced 38,719,973 pounds of copper, against 34,043,005 pounds in 1912 and 36,103,649 pounds in 1911. Gila County, including the Globe and Miami districts, produced 71,609,847 pounds of copper in 1913, against 63,969,423 pounds in 1912 and 49,226,341 pounds in 1911. In Pinal and Gila counties the so-called low-grade schist and porphyry ores yielded 87,073,406 pounds of copper, against 68,753,553 pounds in 1912 and 30,666,515 pounds in 1911. The copper output of Greenlee County is largely from the same class of deposits and, if the copper output from ores milled in that county be added to the output of Ray and Miami, the aggregate yield of the so-called porphyries in Arizona would be 138,471,483 pounds, or nearly a third of Arizona's copper output in 1913.

Source of copper production in Arizona, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Copper-zinc ore.	Total.
Cochise	929,326	163,583,124	589,617	.....	1,787	.....	.....	165,103,854
Coconino	.....	27,024	.....	.....	.....	.....	.....	27,024
Gila	347	71,608,608	892	.....	.....	.....	.....	71,609,847
Greenlee	428	69,466,132	.....	.....	.....	.....	.....	69,466,560
Maricopa	26,912	65,613	.....	.....	.....	.....	.....	92,525
Mohave	2,620	723,899	4,533	.....	.....	16,568	.....	747,620
Pima	54	1,140,367	8,460	1,513	275,536	.....	.....	1,425,930
Pinal	602	55,950,981	100	.....	557	.....	.....	55,952,240
Santa Cruz	4,481	3,949,582	25,810	.....	32,455	.....	.....	4,012,328
Yavapai	12,177	38,689,400	1,259	837	1,500	3,758	11,042	38,719,973
Yuma	6,453	758,904	144	.....	.....	.....	.....	765,501
Total	[a] 983,400	405,963,634	630,815	2,350	311,835	20,326	11,042	407,923,402

[a] Includes 46,967 pounds from gold ore, 3,589 pounds from gold and silver ore, 13,736 pounds from silver ore, and 919,108 pounds, chiefly from pyritic iron ore.

LEAD.

The output of lead in Arizona in 1913 was 16,144,772 pounds, valued at $710,370, against 6,806,443 pounds, valued at $306,290, in 1912, and 10,274,552 pounds in 1911. Cochise County was credited with 7,844,204 pounds, valued at $345,145, as against 3,776,867 pounds, valued at $169,959, in 1912. The largest part came from the vicinity of the copper mines in the Warren district. Mohave County followed with 5,315,646 pounds, Pima County with 1,015,803 pounds, and Santa Cruz County with 541,522 pounds. Concentrates yielded 5,392,323 pounds of lead, and 10,752,449 pounds of lead were contained in crude ore shipped to smelters.

Source of lead production in Arizona, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Copper-zinc ore.	Total.
Cochise	323,229	.....	7,519,117	906	952	.....	.....	7,844,204
Gila	.....	.....	515,849	.....	.....	.....	.....	515,849
Maricopa	341,900	.....	.....	.....	.....	.....	.....	341,900
Mohave	1,907	.....	453,041	120,420	.....	4,740,278	.....	5,315,646
Pima	206	9,152	168,981	.....	837,464	.....	.....	1,015,803
Pinal	.....	.....	1,237	.....	1,222	.....	.....	2,459
Santa Cruz	167	.....	498,116	.....	43,239	.....	.....	541,522
Yavapai	9,846	54	130,396	14,745	14,372	72,118	838	242,369
Yuma	2,160	.....	322,860	.....	.....	.....	.....	325,020
Total	[a] 679,415	9,206	9,609,597	136,071	897,249	4,812,396	838	16,144,772

[a] Includes 348,076 pounds from gold ore, 1,824 pounds from gold and silver ore, and 329,515 pounds from silver ore.

ZINC.

In 1913 the spelter production from Arizona zinc-bearing ores was 9,428,067 pounds, valued at $527,972, against an output of 8,758,243 pounds, valued at $604,319, in 1912, and 4,562,984 pounds in 1911. Mines at Union Pass and Chloride, in Mohave County, yielded 7,031,400 pounds of spelter in 1913, against 8,304,462 pounds in 1912 and 4,476,552 pounds in 1911. Zinc ore mined in Pima County yielded 2,127,568 pounds of spelter, against 111,737 pounds in 1912. Production of zinc was also recorded in Cochise and Yavapai counties. The development of the carbonate and sulphide zinc deposits in the Pima district of Pima County, especially those of the San Xavier mine, became important in 1913.

Source of zinc (spelter) production in Arizona, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Copper-zinc ore.	Total.
Cochise	57,566	.....	.....	57,566
Mohave	2,797,758	4,233,642	.....	7,031,400
Pima	2,127,568	.....	.....	2,127,568
Yavapai	37,146	117,227	57,160	211,533
Total	5,020,038	4,350,869	57,160	9,428,067

Zinc ore and concentrates produced from Arizona mines mills, sold in 1913, and source by counties.

County.	Classification.	Quantity.	Average assay of ore or concentrate.[a]
		Short tons.	*Per cent of zinc.*
Mohave, Cochise, and Yavapai	Sulphide zinc ore	1,465	40.40
Yavapai	Sulphide zinc-lead ore	214	32.22
Cochise and Pima	Carbonate ore	4,413	28.64
Mohave and Yavapai	Concentrates (sulphide)	8,848	40.92
Total ore and concentrates	.....	14,940	37.12

[a] Actual assay content.

MINING INDUSTRY IN 1913.

The year 1913 has been a most remarkable epoch in the history of Arizona mines and mining, being the maximum year in the production of ores and yield of gold, silver, copper, lead, and zinc. The great copper-producing district of Bisbee, the region around Globe, and the Miami and Ray districts have furnished the largest part of the increase in the metal output, especially in silver and copper. This increase in output has been accomplished in part by advanced methods of mining and milling, but is due more particularly to the fact that there were no curtailments in production during the year. There were important developments in the newer porphyry districts, such as Ajo in Pima County and Superior in Pinal County, and an effort was made to put the smelter at Sasco in shape to resume operations.

REDUCTION MILLS.

There were 45 milling plants of various kinds in operation in Arizona during the year. Most of these were operated for short periods. Eight milling plants used the amalgamation method; 6, amalgamation and concentration; 3, amalgamation and cyanidation; 7 were straight cyanide mills; 20 were straight concentration mills; and 1 was a combined amalgamation, concentration, and cyanidation mill. The principal mills, including the new plants, are mentioned in their respective districts and a complete list was published in Mineral Resources for 1911. Of the ore milled, 36,338 tons were treated by amalgamation and yielded 14,615.07 ounces of gold and 3,759 ounces of silver, or an average recovery of $8.31 in gold and .10 ounce of silver per ton. The ore treated by cyanidation aggregated 163,642 tons, which, with 11,475 tons of old tailings, yielded 97,122.67 ounces of gold and 69,140 ounces of silver, or an average recovery per ton for ore and tailings of $11.47 in gold and 0.39 ounce of silver. The total value of the bullion recovered from ore and tailings was $2,353,855, as against the output in 1912 amounting to $2,141,667.

Quantity of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Arizona in 1913, by counties.

County	Quantity.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Cochise	2,540	.....	.....	398.00	20,260	$20,464
Gila	10	6.00	2	.....	.....	125
Maricopa	33,230	13,134.57	3,120	[a] 8,324.42	[a] 4,960	448,477
Mohave	160,791	182.75	118	[b] 87,073.05	[b] 41,189	1,828,688
Pinal	304	104.29	38	81.76	43	3,894
Santa Cruz	349	363.69	177	.....	.....	7,625
Yavapai	2,032	743.58	264	37.12	95	16,356
Yuma	724	80.19	40	[c] 1,208.32	[c] 2,593	28,226
Total	199,980	14,615.07	3,759	97,122.67	69,140	2,353,855

[a] Includes bullion from 775 tons of old tailings.
[b] Includes bullion from 400 tons of old tailings.
[c] Includes bullion from 10,300 tons of old tailings.

Mills equipped for the concentration of low-grade ore treated 5,141,337 tons, or nearly 65 per cent of the total ore mined. The concentrates produced aggregated 454,393 tons, containing $308,090 in gold, 393,553 ounces of silver, 147,327,295 pounds of copper (or 36 per cent of the total copper output of the State), 5,392,323 pounds of lead, and 6,155,974 pounds of zinc (spelter), valued in all at $23,963,524, or an average of $52.74 per ton. Copper concentrates aggregating 435,389 tons comprised nearly 96 per cent of the total concentrates produced. The two following tables give the quantity of ore concentrated and of concentrates with their metallic content by counties; also the production by kinds of concentrates and the averages for 1911–1913:

Mine production of gold, silver, copper, lead, and zinc from Arizona concentrates in 1913.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Gila	1,210,922	90,510	1,041.54	149,488	40,495,097			$6,388,562
Greenlee	1,494,447	190,232	188.24	6,478	51,398,077			7,974,506
Maricopa		1,027	7,186.18	8,141	26,683	341,829		172,645
Mohave	35,145	17,536	2,524.33	133,329	18,425	4,943,909	6,098,814	694,635
Pima	441	147	6.24	4,952	6,684	84,238		7,862
Pinal	2,371,468	145,678	2,897.32	65,543	54,015,425			8,471,872
Santa Cruz	81	43	128.75	3,616	985	158		5,004
Yavapai	28,794	9,201	919.18	20,777	1,365,079	4,478	57,160	246,538
Yuma	39	19	12.08	1,229	840	17,711		1,900
Total	5,141,337	454,393	14,903.86	393,553	147,327,295	5,392,323	6,155,974	23,963,524

By kinds of concentrates.

Dry or siliceous		216	371.37	6,036	5,490	158		12,183
Copper		435,389	4,727.00	240,193	147,262,544			23,068,486
Lead		9,934	9,192.64	128,952	50,355	5,293,361		508,629
Zinc		8,848	600.85	17,562	8,066	96,644	6,155,974	373,264
Copper-lead		6	12.00	810	840	2,160		962

Kinds of concentrates and average metallic content of each kind produced in Arizona in 1911–1913.

Kinds of concentrates and source of production.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
Gold and silver mills—							
1911	1,885	$60.52	8.92	0.98			$67.71
1912	772	135.15	6.89	.79	7.91		149.38
1913	66	72.41	42.41	.34			103.11
Concentration mills—							
1911	837	13.75	130.17	.39	1.87		85.42
1912	814	25.52	140.25	1.32	4.52		119.95
1913	150	19.32	21.58	1.68			35.84
Copper:							
Concentration mills—							
1911	304,123	.11	.60	15.64			39.52
1912	400,134	.06	.46	16.93			56.22
1913	435,389	.22	.55	16.91			52.98
Lead:							
Concentration mills—							
1911	3,467	8.68	12.68	.21	33.33		45.93
1912	88	63.34	68.50	.05	6.53		111.52
1913	8,892	4.60	13.56	.13	27.82		37.68
Gold and silver mills—							
1913	1,042	143.10	8.02	1.30	16.58		166.57
Zinc:							
Concentration mills—							
1911	4,045	4.91	7.36	.06	1.77	38.13	54.02
1912	7,524	5.51	7.37	.81	2.48	31.75	58.76
1913	8,848	1.40	1.98	.05	.55	34.79	42.19
Copper-lead:							
Concentration mills—							
1913	6	41.33	135.00	7.00	18.00		160.33
Lead-zinc:							
Concentration mills—							
1911	39	25.21	20.51	1.13	30.09	11.43	79.00
1912	2,295	6.72	10.28	.96	25.05	17.06	59.45

SMELTING IN ARIZONA IN 1913.

There were 11 copper-smelting plants operating and 1 new plant under construction in Arizona in 1913, as shown in the following table:

Smelting plants for copper ore in Arizona in 1913.

Name.	Situation of plant.	Principal equipment.
Cochise County:		
Copper Queen	Douglas	10 400-ton blast furnaces, 4 reverberatories, 12 75-ton McDougal calciners, and 8 converters.
Calumet & Arizona [a]	....do	2 blast furnaces, 4 reverberatories, 12 Hereshoff roasters, and stands for 6 converters (Great Falls type).
Greenlee County:		
Arizona Copper	Clifton	3 reverberatories and 3 converter stands.
Detroit	Morenci	5 blast furnaces and 3 converters.
Shannon	Clifton	3 blast furnaces and 2 converter stands.
Gila County:		
Old Dominion	Globe	6 blast furnaces and 3 converters.
American	Hayden	2 reverberatories and 3 converters.
Pima County:		
Pioneer	Corwin	1 blast furnace.
Yavapai County:		
Consolidated Arizona	Humboldt	1 250-ton blast furnace for copper, 3 reverberatories, and 2 converters; also 1 200-ton lead furnace.
United Verde	[b] Clarkdale, 6 miles from mine.	4 blast furnaces, 3 19 by 100 foot reverberatories, 4 converters, and 6 Wedge roasters.
Do	Jerome	6 blast furnaces, 1 Knudsen furnace, and 8 converter stands with 15 shells.
Yuma County:		
Swansea Consolidated	Swansea	1 Mitchell blast furnace, 1 reverberatory, and 2 converters.

[a] Completed, 1913. Old smelter was blown in Nov. 15, 1902; enlarged, 1907–8; again enlarged, 1910; old works increased to a capacity of 3,000 tons daily.
[b] Under construction. Expected to be in commission about July, 1914.

Modern smelting plants were added to the equipment of the Arizona Copper Co. and of the Calumet & Arizona, and these, with the new plant of the United Verde Copper Co. at Clarkdale, in Yavapai County, were the most important steps toward the development of the copper interests of Arizona during the year 1913. The Arizona Copper Co. is reported as having abandoned its old smelter at the mouth of Chase Creek and constructed larger works on the line of the railroad to the southwest of Clifton. The company replaced cupola furnaces with reverberatories, because the percentage of the first-class lump ore has declined to such an extent as to require preliminary mechanical concentration. The three new reverberatories of the largest type, 120 feet in length, should smelt 400 to 500 tons each per day. The new smelter [1] of the Calumet & Arizona at Douglas has been erected adjacent to the site of the old one, but is designed for both cupola and reverberatory work and is larger than the old. The Swansea copper plant in Yuma County was operated early in 1913 on custom ores, but closed, it is said, as a result of litigation in March. The Pioneer plant, near Corwin, was handling 180 tons of copper ore per day in March, but in May the plant was idle and continued so the remainder of the year.

[1] Douglas, James, Copper metallurgy in Arizona in 1913: Eng. and Min. Jour., Jan. 10, 1914, p. 60.

Mine production of gold, silver, copper, lead, and zinc from Arizona crude ore shipped to smelters in 1913.

By counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cochise	1,439,175	38,452.85	2,030,632	161,528,377	7,844,204	57,566	$27,406,660
Coconino	216	.....	237	27,024	.....	.....	4,332
Gila	276,480	1,118.16	198,708	30,426,353	515,849	.....	4,883,364
Greenlee	229,639	641.44	29,579	17,699,506	.....	.....	2,774,549
Maricopa	259	112.80	15,360	65,842	71	.....	21,818
Mohave	4,856	901.08	72,066	729,195	371,737	932,586	243,762
Pima	21,925	172.46	59,459	1,419,246	931,565	2,127,568	419,595
Pinal	7,051	218.37	96,217	1,936,815	2,459	.....	362,943
Santa Cruz	22,232	788.43	56,041	4,011,343	541,364	.....	695,725
Yavapai	412,789	22,722.29	830,916	37,318,656	237,891	154,373	6,775,087
Yuma	11,340	713.23	13,793	705,152	307,309	.....	145,895
Total	2,425,962	65,911.11	3,403,008	255,867,509	10,752,449	3,272,093	43,733,730

By kinds of ore.

Dry or siliceous	61,395	4,131.45	235,105	947,828	331,628	.....	$388,914
Copper	2,327,438	59,449.75	2,636,284	253,977,607	9,206	.....	42,188,185
Lead	26,203	1,721.47	484,166	624,131	9,386,457	.....	837,766
Zinc	5,878	270.14	9,097	2,350	55,791	3,154,866	190,570
Copper-lead	4,834	329.45	33,565	311,835	897,249	.....	114,897
Lead-zinc	214	8.85	4,791	3,758	72,118	117,227	13,398

Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Arizona, in 1911–1913.

Kind of crude ore.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
		Value per ton.	*Fine ounces per ton.*				
Dry or siliceous:	*Short tons.*			*Per cent.*	*Per cent.*	*Per cent.*	
1911	48,037	$1.63	4.49	0.68	0.01	.....	$5.71
1912	7,276	10.02	19.70	.37	.14	.....	23.48
1913	61,395	1.39	3.83	.77	.27	.....	6.33
Copper:							
1911	1,655,989	.62	1.18	6.30	.....	.....	17.01
1912	2,106,929	.55	1.04	5.31	.....	.....	18.72
1913	2,327,438	.53	1.13	5.46	.....	.....	18.13
Lead:							
1911	21,190	6.45	29.69	.63	17.61	.....	39.63
1912	20,696	6.09	28.66	.18	10.98	.....	34.18
1913	26,203	1.35	18.48	1.19	17.91	.....	31.97
Zinc:							
1911	2,106	4.31	8.09	.04	2.57	34.89	50.79
1912	4,264	5.43	7.51	.94	2.40	33.76	61 96
1913	5,878	.95	1.55	.02	.47	26.84	32.42
Copper-lead:							
1911	129	2.08	39.55	4.11	39.38	.....	68.76
1912	315	5.51	59.30	4.24	18.21	.....	72.38
1913	4,834	1.41	6.94	3.23	9.28	.....	23.77
Lead-zinc:							
1912	528	.74	17.61	.64	15.93	30.14	69.61
1913	214	.85	22.39	.88	16.85	27.39	62.61

A classification of kinds of crude ore smelted, separated into oxidized and sulphide ores, with average content, is shown in the two tables following:

Oxidized and sulphide crude ores, by kinds, including mixed dry ores and carbonate ores, produced in Arizona, and shipped to smelters in 1913.

Kind of ore.	Quantity.	Metal content.					Total value.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter.)	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	61,395	4,131.45	235,105	947,828	331,628	.....	$388,914
Copper:							
Oxidized	1,144,459	18,824.03	1,110,388	126,743,328	54	.....	20,705,019
Sulphide	1,182,979	40,625.72	1,525,896	127,234,279	9,152	.....	21,483,166
Lead:							
Oxidized	6,228	261.91	97,731	339,097	2,259,762	.....	216,434
Sulphide	19,975	1,459.56	386,435	285,034	7,126,695	.....	621,332
Zinc:							
Oxidized	4,413	.....	2	1,513	906	2,148,631	120,599
Sulphide	1,465	270.14	9,095	837	54,885	1,006,235	69,971
Copper-lead:							
Oxidized	4,699	285.56	27,688	294,441	864,232	.....	106,291
Sulphide	135	43.89	5,877	17,394	33,017	.....	8,606
Lead-zinc:							
Sulphide	214	8.85	4,791	3,758	72,118	117,227	13,398
Total	2,425,962	65,911.11	3,403,008	255,867,509	10,752,449	3,272,093	43,733,730

Oxidized and sulphide ore averages per ton, by kinds, produced in Arizona and shipped to smelters in 1912–1913.

Kind of ore.	Quantity.	Average metallic content.					Total value.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ozs. per ton.*	*Fine ozs. per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1912	7,276	0.48	19.70	0.37	0.14	.....	$23.48
1913	61,395	.07	3.83	.77	.27	.....	6.33
Copper:							
Oxidized—							
1912	878,540	.01	.75	5.32	.....	.....	18.34
1913	1,144,459	.02	.97	5.54	.....	.....	18.09
Sulphide—							
1912	1,228,389	.03	1.24	5.31	.....	.....	19.00
1913	1,182,979	.03	1.29	5.38	.....	.....	18.16
Lead:							
Oxidized—							
1912	7,491	.19	22.50	.21	6.79	.....	24.58
1913	6,228	.04	15.69	2.72	18.14	.....	34.75
Sulphide—							
1912	13,205	.35	32.15	.16	13.36	.....	39.62
1913	19,975	.07	19.35	.71	17.84	.....	31.11
Zinc:							
Oxidized—							
1912	233	.....	.....	.....	.....	29.08	40.14
1913	4,413	.....	.....	.02	.....	24.34	27.33
Sulphide—							
1912	4,031	.28	7.94	.99	2.63	34.03	63.22
1913	1,465	.18	6.21	.03	1.87	34.34	47.76
Copper-lead:							
Oxidized—							
1912	46	.12	272.00	4.19	19.93	.....	201.63
1913	4,699	.06	5.89	3.13	9.20	.....	22.62
Sulphide—							
1912	269	.29	22.93	4.25	17.92	.....	50.27
1913	135	.32	43.53	6.44	12.23	.....	63.75
Lead-zinc:							
Sulphide—							
1912	528	.03	17.61	.64	15.93	30.14	69.61
1913	214	.04	22.39	.88	16.85	27.39	62.61
Total—1912	2,140,008	.03	1.39	5.24	.12	.07	19.00
1913	2,425,962	.03	1.40	5.27	.22	.07	18.03

The State output by counties is shown in the following tables, which give the metallic output of each county with total value, and also the tonnages and average values compared for 1912 and 1913.

Mine production of gold, silver, copper, lead, and zinc in Arizona, in 1913, by counties.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ozs.		*Fine ozs.*			*Fine ozs.*	
Cochise			39,091.60	$808,095	$808,095	2,127,191	$1,284,823
Coconino						237	143
Gila			2,235.70	46,216	46,216	348,198	210,312
Greenlee	9.77	$202	829.68	17,151	17,353	36,059	21,780
Maricopa	51.66	1,068	28,757.97	594,480	595,548	31,584	19,077
Mohave			90,681.21	1,874,547	1,874,547	246,702	149,008
Pima	405.91	8,391	178.70	3,694	12,085	64,477	38,944
Pinal	53.50	1,106	3,301.74	68,253	69,359	161,849	97,757
Santa Cruz			1,280.87	26,478	26,478	59,834	36,140
Yavapai	493.91	10,210	24,526.42	507,006	517,216	854,049	515,845
Yuma	469.92	9,714	2,288.13	47,300	57,014	17,911	10,818
Total	1,484.67	30,691	193,172.02	3,993,220	4,023,911	3,948,091	2,384,647

County.	Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Cochise	165,103,854	$25,591,097	7,844,204	$345,145	57,566	$3,224	$28,032,384
Coconino	27,024	4,189					4,332
Gila	71,609,847	11,099,526	515,849	22,697			11,378,751
Greenlee	69,466,560	10,767,317					10,806,450
Maricopa	92,525	14,341	341,900	15,044			644,010
Mohave	747,620	115,881	5,315,646	233,889	7,031,400	393,758	2,767,083
Pima	1,425,930	221,019	1,015,803	44,695	2,127,568	119,144	435,887
Pinal	55,952,240	8,672,597	2,459	108			8,839,821
Santa Cruz	4,012,328	621,911	541,522	23,827			708,356
Yavapai	38,719,973	6,001,596	242,369	10,664	211,533	11,846	7,057,167
Yuma	765,501	118,653	325,020	14,301			200,786
Total	407,923,402	63,228,127	16,144,772	710,370	9,428,067	527,972	70,875,027

Tons of ore sold or treated, number of deep mines producing, and value of ores in Arizona in 1912 and 1913, by counties.

County.	Ore sold or treated.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1913	Increase (+) or decrease (—).	1912	1913	1912	1913	1912	1913
	Short tons.	*Short tons.*						
Cochise	1,559,874	+ 178,716	50	51	$19.30	$17.97	$1.53	$1.34
Coconino	216	+ 48	2	3	9.54	20.06	.36	.66
Gila	1,501,620	+ 51,419	32	28	7.41	7.58	.13	.17
Graham		— 83	3		50.32		42.99	
Greenlee	1,734,982	— 11,923	27	17	7.31	6.23	.05	.02
Maricopa	34,264	+ 14,141	9	21	16.48	18.76	15.66	17.91
Mohave	206,239	+ 3,302	39	44	13.66	13.42	9.89	9.81
Pima	22,366	— 7,285	53	45	13.18	19.11	1.04	1.91
Pinal	2,378,823	+ 801,612	15	18	3.95	3.72	.05	.07
Santa Cruz	22,662	+ 8,380	30	40	27.68	31.26	5.04	2.76
Yavapai	447,659	+ 41,606	93	92	16.22	15.74	2.28	2.28
Yuma	23,157	+ 11,847	41	43	11.27	8.25	3.09	2.51
Total	7,931,862	+1,091,780	394	402	9.80	8.93	.86	.80

[a] Value per ton, placer product excluded.

REVIEW OF MINING INDUSTRY BY COUNTIES.

COCHISE COUNTY.

Number of producers, quantity of ore sold or treated in Cochise County, Ariz., in 1904–1913, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	14	686,767	$389,437	1,152,466	90,850,611	799,912	.....	$12,440,572
1905	19	950,765	430,388	1,453,312	108,498,440	2,677,980	.....	18,359,810
1906	21	1,195,648	[a] 618,270	[a] 1,757,369	130,029,016	2,124,605	.....	27,012,409
1907	49	1,080,986	[a] 435,560	[a] 1,411,301	110,024,926	1,654,773	.....	23,459,707
1908	27	1,136,662	[a] 529,318	[a] 1,630,749	126,554,764	1,978,097	173,313	18,190,070
1909	38	1,222,095	496,951	1,454,390	140,810,472	2,004,018	713,116	19,683,276
1910	38	1,294,282	[a] 587,476	[a] 1,208,274	145,310,623	1,176,416	.....	19,746,155
1911	44	1,167,237	783,981	1,946,319	132,290,007	6,907,388	22,423	18,663,891
1912	50	1,381,158	910,315	1,962,644	147,654,661	3,776,867	23,800	26,651,961
1913	51	1,559,874	808,095	2,127,191	165,103,854	7,844,204	57,566	28,032,384
Increase (+) or decrease (−) in 1913		+178,716	−102,220	+164,547	+17,449,193	+4,067,337	+33,766	+1,380,423

[a] Includes small placer production.

Fifty-one producers, 1 more than reported in 1912, mined 1,559,874 tons of ore, an increase of 178,716 tons over the output of 1912. The total value of the metals from this ore was $28,032,384, against $26,651,961 in 1912, a gain of $1,380,423, due largely to the increase in ore production. The total average value per ton decreased on the same account from $19.30 in 1912 to $17.97 in 1913, and the gold and silver value in this ore from $1.53 to $1.34. Gains were made in output of all the metals with the exception of gold, which decreased from $910,315 in 1912 to $808,095 in 1913. The silver yield, valued at $1,207,026 in 1912, increased to $1,284,823 in 1913; the copper production from $24,363,019 in 1912 to $25,591,097 in 1913; the lead output from $169,959 in 1912 to $345,145 in 1913; and the zinc output from $1,642 in 1912 to $3,224 in 1913. Copper ores of shipping grade treated at smelters aggregated 1,359,151 tons and contained 34,987.99 ounces of gold, 1,560,763 ounces of silver, and 116,007,647 pounds of copper. Shipments of lead ore were made to El Paso aggregating 20,690 tons, containing 1,155.02 ounces of gold, 277,252 ounces of silver, 589,617 pounds of copper, and 7,519,117 pounds of lead. It was estimated that of the copper ores produced 659,985 tons were oxidized and 699,166 tons were sulphides. Of the lead ores, 4,967 tons were oxidized and 15,723 tons were sulphides. No placer productions were reported.

California district.—Four producers shipped from the district 83 tons of ore of smelting grade, containing principally lead, copper, and silver. The total value of the output was $3,661, or an average value of $44.11 per ton. The production was made from the Paradise claims, Willie Rose, and Harris properties.

Cochise or Johnson district.—The output of the district aggregated 4,393 tons of ore, all of which was shipped directly to the smelter and contained $80 in gold, 19,297 ounces of silver, 791,971 pounds of copper, 27,878 pounds of lead, and 21,063 pounds of zinc, valued in

all at $136,898, or an average value per ton of $31.16. Ore was shipped from the group of claims of which the Copper Chief forms a part, and also from the Republic, Black Prince, Peabody, Centurion, Empire, Climax, Peacock, and Texas-Arizona mines. The last named property produced oxidized lead ore and zinc ore.

Dos Cabezos district.—Very little was accomplished in the production of the district outside of the ore produced from the property of the Mascot Copper Co., operating the Batchelder group, which yielded largely sulphide ore and a small tonnage of carbonate copper ore. The total output of gold, silver, and copper made by three producers amounted to $8,324.

Hartford or Huachuca district.—Four producers shipped 103 tons of ore, the larger part of which was copper sulphide ore, containing $262 in gold, 3,287 ounces of silver, and 20,422 pounds of copper, valued in all at $5,412, or an average value per ton of $52.54. The principal producer was the Smuggler property and a test shipment was made from the Wisconsin group.

Swisshelm district.—A small tonnage of lead ore containing silver and a small quantity of copper was shipped from the district in 1913.

Tombstone district.—Nine producers shipped 5,760 tons of ore containing $25,415 in gold, 126,392 ounces of silver, 10,657 pounds of copper, 334,923 pounds of lead, and 36,503 pounds of zinc, valued in all at $120,189, or an average value per ton of $20.87. Zinc sulphide ore was produced from the Side Show mine of the San Juan group of claims. The largest part of the remainder of the output was shipped by lessees from the mines of the Tombstone Consolidated.

Turquoise or Courtland district.—Seven producers supplied 132,677 tons of ore, yielding $58,817 in gold, 168,950 ounces of silver, 6,227,897 pounds of copper, and 30,032 pounds of lead, valued in all at $1,127,508, or an average value per ton of $8.50. This output includes an estimated quantity of gold and silver from tests on ore made in starting the new Commonwealth mill in October. The milling plant has 30 stamps, 3 Hardinge mills, and 3 tube mills, Pachuca tanks for agitation, and 4 Dorr tanks for settling; the pulp is run through 4 Oliver filters. The mill will treat about 350 tons of ore per day. There were also shipped from the district 23,711 tons of tailings, yielding 238.75 ounces of gold and 68,432 ounces of silver. The Germania property of the Calumet & Arizona Co. was the largest producer of oxidized copper ore. All mining operations were discontinued on November 30 and the mine was turned over to lessees. All supplies and equipment were either shipped to Bisbee or sold on the ground. The Mary & Mamie property yielded sulphide and oxidized copper ores. Other producers were the Maid of Sunshine, Ontario, Kendall, and Leonard mines. The last-named property, owned by the Shannon Copper Co., yielded a pyritic iron ore carrying small quantities of copper, which were shipped to Clifton.

Warren district.—The output reported by 12 producers in 1913 aggregated 1,416,483 tons of ore, containing $722,517 in gold, 1,806,973 ounces of silver, 158,005,560 pounds of copper, and 7,392,404 pounds of lead, valued in all at $26,630,057, or an average value per ton of $18.80. All of the ore, including 94,448 tons of old slag, was of shipping grade, the copper ore and slag going to Douglas and 19,470 tons of lead ore to El Paso, Tex. During 1913 there were

shipped from the Copper Queen property [1] 867,481 tons of ore, old dump slag, precipitates, and lease material. From this tonnage there were produced 16,216 ounces of gold, 919,138 ounces of silver, 97,181,725 pounds of copper, and 5,701,628 pounds of lead. The lead was contained in ore carrying gold and silver shipped to the El Paso lead plant.

Shipments to El Paso in 1913 were richer in lead, but leaner in silver. The tonnage increased about 40 per cent. The lead contents increased nearly 100 per cent, while the silver dropped 123,748 ounces, or 38 per cent. There was less ore, lean in lead but high in silver, mined by leasors. From the old Bisbee slag dump 30,000 tons were shipped in excess of 1912. The slag yielded 1.94 per cent of copper. The tonnage of copper-bearing material treated by the reduction works showed an increase over 1912 of 71,443 dry tons. * * * Again in 1913 the production of the mines of this company was greater than that of any previous year both in tonnage of ore and metal contents. The grade was higher than that of 1912 through the exercise of the system of careful sampling and sorting, inaugurated two years ago. The total amount of development work exceeded one hundred thousand (100,000) feet and served to greatly increase the ore reserves over any previously determined tonnage. Reference was made in my last report to the proposed active exploration of the porphyries adjacent to the main limestone contact, which gave promise of important bodies of low-grade disseminated ore. In this section systematic work has exposed a large amount of smelting, as well as larger quantities of concentrating grades, which will necessitate for their economical reduction the installation of a concentrator. The operation of the reduction works at Douglas shows a further decrease in cost of producing copper. * * *

Two very important ore bodies have been discovered, one at the Lowell, the other in the Sacramento division. But the most interesting development in its favorable bearing on the future of the district has been the exposure of ore on the Wade Hampton and White Tail Deer, two claims long neglected, but members of large groups owned by the Copper Queen to the west of Bisbee. The policy of increasing reserves and carrying development work well in advance of mining has been continued, with gratifying results.

Copper ore produced, shipped, and sampled at the smelter from the Calumet & Arizona mine [2] aggregated 107,701 dry tons, yielding an average of 4.485 per cent of copper. From the Superior & Pittsburg mine [2] 376,568 dry tons were shipped and sampled, yielding 5.785 per cent of copper. The aggregate metal yield of both properties was 52,621,651 pounds of copper, 540,213.89 ounces of silver, and 15,890.65 ounces of gold. Dividends were paid in 1913 amounting to $3,059,208.75. The total development performed on both properties of drifts, raises, stations, and shafts aggregated 62,836 feet. This company has done much exploration work during 1913 in the Pioneer district, Pinal County, and in the Ajo district, in Pima County. It will also continue diamond drilling in the Mammoth district of Pinal County and the Amole district of Pima County.

On the 26th of June the old smelter of the company[2] at Douglas was closed and dismantling begun to make room for the new bedding system, part of which extends into the old plant. All of the old plant has now been dismantled and most of it removed. The power house, boiler house, receiving bins, and trestle remain, with alterations, to meet the conditions of the new plant. No. 2 blast furnace of the new smelter was blown in on June 2. No. 1 blast furnace was blown in on June 26. Both furnaces started without any serious trouble and have been operated with complete satisfaction. No. 1 reverberatory was fired up August 30 and run on a straight charge of flue dust until the roasters were started. * * * Fire was started in the first roaster on November 10. Since then the number of roasters in operation has been increased from time to time until there are now 10 in operation. The converters were put in operation June 6 when the first tap was made from No. 2 furnace. Lords-

[1] Phelps-Dodge & Co. Ann. Rept. for year ending Dec. 31, 1913.
[2] Calumet & Arizona Copper Co. Ann. Rept. for year ending Dec. 30, 1913.

burg ore and Pearce tailings have been used as flux. * * * The Calumet & Arizona Mining Co.'s smelter has to-day no superior. It is capable of treating all classes of ore at lower cost than heretofore and with increased capacity and higher recovery of values.

From the Shattuck-Arizona mine[1] 89,343 dry tons of copper ore and 4,874 tons of lead ore were shipped to the smelting plants at Douglas and El Paso in 1913, yielding 13,219,756 pounds of copper, 236,000 ounces of silver, 2,033.43 ounces of gold, and 1,483,956 pounds of lead.

Ore production during the past year was regulated by the ability of the new Calumet & Arizona smelter to handle our ore. A gradual increase in the ore shipments is being made and I expect an increase in the copper, gold, silver, and lead output during the coming year. New ore bodies are being opened up and, as a whole, the mine is looking better than at any other time in its history. * * * Development on the 300-foot level has exposed a variety of ore, inasmuch as we have opened up a large body of gold-bearing siliceous matter which averages about $30 per ton in gold values. Silver and lead exist in commercial quantities, and a fine shoot of copper-lead ore has been discovered, in size approximately 180 by 50 by 30 feet, in which the copper contents will average 12 per cent, lead 10 per cent, silver 10 ounces per ton, and gold $1 per ton. These ores containing lead and copper require careful sorting which makes for higher copper costs, but the credits from lead ore shipped more than offset the sorting cost. * * * One of the important finds on the 600-foot level during the year was a large body of lead carbonate ore. * * * The ore is associated with lead and copper. * * * A good sized body of semioxidized sulphide ore, at present 75 feet in length and 25 feet in width, assaying about 6 per cent copper, is being opened up about 900 feet east of the shaft on the 800-foot level. * * * During 1913 the 900-foot level was unwatered and new drifts are being pushed east of the shaft.

COCONINO COUNTY.

Three operators of deep mines reported the production in Coconino County of 216 tons of ore containing 237 ounces of silver and 27,024 pounds of copper, valued at $4,332. Nearly all of the ore was from the Francis district, produced from the Goodenough claims.

GILA COUNTY.

Number of producers, quantity of ore sold or treated in Gila County, Ariz., in 1905–1913, and content in gold, silver, copper, and lead.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	10	241,328	$50,997	84,982	24,991,794	.....	$4,001,046
1906	14	415,471	47,916	122,098	28,492,391	.....	5,628,753
1907	42	444,860	[a] 62,039	[a] 94,062	36,875,993	161,523	7,507,880
1908	24	442,430	54,780	164,900	37,380,914	70,487	5,079,418
1909	23	445,688	[a] 25,408	[a] 155,493	39,451,896	13,442	5,235,588
1910	46	312,057	[a] 25,229	[a] 174,696	31,330,222	6,102	4,098,772
1911	44	735,432	[a] 50,310	[a] 247,813	49,226,341	10,466	6,335,415
1912	32	1,450,201	33,939	264,941	63,969,423	47,349	10,753,964
1913	28	1,501,620	46,216	348,198	71,609,847	515,849	11,378,751
Increase (+) in 1913	.....	+51,419	+12,277	+83,257	+7,640,424	+468,500	+624,787

[a] Includes small placer production.

Twenty-eight producers in 1913 reported the output of 1,501,620 tons of ore. This is 51,419 tons greater than the quantity produced by 32 operators in 1912. The total average value per ton of the ore

[1] Shattuck Arizona Copper Co. Rept. for 17 months ending Dec. 31, 1913.

increased from $7.41 in 1912 to $7.58 in 1913, and the gold and silver value in this ore from 13 cents to 17 cents. The ores mined yielded $46,216 in gold, an increase of $12,277 compared with 1912; the silver yield increased in value from $162,939 to $210,312; copper from $10,554,955 to $11,099,525; lead from $2,131 to $22,697; and the total value of this production from $10,753,964 to $11,378,751. The copper ores of concentrating grade aggregated 1,210,922 tons, producing 90,510 tons of concentrate containing 1,041.54 ounces of gold, 149,488 ounces of silver, and 40,495,097 pounds of copper. The crude ore shipped directly to smelters, mostly copper ore, aggregated 276,480 tons, containing 1,188.16 ounces of gold, 198,708 ounces of silver, and 30,426,353 pounds of copper, and 515,849 pounds of lead. The larger part of the copper ore shipped to smelters aggregated 254,816 tons, and was oxidized; the sulphide ore amounted to 20,567 tons. The smelting ores yielded metals valued at $4,883,364, or an average value of $17.66 per ton.

Banner district.—The district output of 4,103 tons of ore contained $5,143 in gold, 4,760 ounces of silver, 358,590 pounds of copper, 502,602 pounds of lead, valued in all at $85,713, or an average value per ton of $20.89. The Gila Canyon Copper Co. shipped the largest quantity of oxidized copper ore, containing a small quantity of silver and gold. The sulphide ores of shipping grade in this property are not opened in quantity, but adits are being made to tap the zone at lower levels. The London-Arizona Copper Co. was the second largest producer of similar ore.

Globe district.—Twenty-two producers reported the production of 1,497,506 tons of ore, which forms the largest part of the total output of the county. The 1913 output slightly increased over that of 1912, which aggregated 1,449,013 tons. The largest producers of concentrating ore were the Miami, Old Dominion, and United Globe properties. All of the ore treated by concentration plants in the district in 1913 aggregated 1,210,922 tons, which yielded 90,510 tons of concentrates containing 1,041.54 ounces of gold, 149,488 ounces of silver, and 40,495,097 pounds of copper. Ore shipped directly to the smelters aggregated 272,376 tons and contained 939.37 ounces of gold, 193,945 ounces of silver, 30,066,718 pounds of copper, and 13,247 pounds of lead. In addition, there were re-treated 14,208 tons of old slag, from which was recovered 688,397 pounds of copper.

The Old Dominion mine [1] produced 169,961 tons of ore in 1913, yielding 18,945,153 pounds of fine copper, 51,316.94 ounces of silver, and 419.82 ounces of gold. There were milled 47,785 tons of ore, which assayed 3.56 per cent of copper, as compared with 106,232 tons assaying 3.15 per cent of copper in 1912. The smelting ore aggregated 120,257 tons of 6.85 per cent grade in 1913, as compared with 93,592 tons of 6.43 per cent grade in 1912.

Dividends amounting to $607,500 were paid in 1913, making a total of $3,361,500 since July 18, 1907. Lessees mined during the year 4,157 tons from the levels above the second, and 20 tons from the Old Dominion Keystone. At the end of the year all leases in the Old Dominion mine were discontinued. One thousand nine hundred and fifty tons of ore were shipped to the smelter from the "Alice" dump, and 972 tons from the "Interloper" dump, this latter ore carrying over 5 per cent copper. * * * During the year 1,284.71 million gallons were pumped from the mine, compared with 1,441.48 million gallons in 1912. * * * The average flow of water in the

[1] Old Dominion Copper Mining & Smelting Co. Ann. Rept. for year ending Dec. 31, 1913.

mine during 1913 was 3,518,221 gallons per 24 hours, or 420,253 gallons less than in 1912, and 19,296 gallons more than in 1911. About 50 per cent of the total flow still continues to come from the dacite on the twelfth level west, and most of the remainder from the sixteenth level. The rate of flow varied from a minimum in March of 2,915,000 gallons per 24 hours to a maximum of 4,678,000 gallons per 24 hours in December, when unwatering the 1,800 winze. The new water drift on the 1,200 was connected with the water flow in the dacite in June, and since that time has been handling all the water from that country. * * * Experiments are now being made with the view to determining the adaptability of the Mineral Separation Co.'s oil flotation process for treating fine slime, which is the class of material on which there has always been the greatest loss. * * * Early in 1913 it was expected that the new 500-ton concentrator would be completed by the end of the year, but it was found necessary to do so much experimental work in connection with deciding on the flow sheet to be adopted that, although the building itself is completed, the order for the interior equipment has not yet been definitely placed, and the concentrator will probably not be running before August next (1914). * * * During the past year over 9,000 tons of slag were shipped from the Creek, and probably there are several thousand more tons remaining that can be handled at a profit.

From the United Globe mine [1] were supplied 162,835 tons of ore and 5,084 tons of old slag in 1913, compared with 132,076 tons of ore and 55,357 tons of old slag in 1913. The oxidized copper ore averaged 6.74 per cent of copper; the sulphide, 2.07 per cent; the concentrating ore, 2.61 per cent; and the silica converter lining, 4.50 per cent. The average assay of the slag was 1.95 per cent of copper. Shipments were made to the Old Dominion, Copper Queen, El Paso, Hayden, and Cananea smelting plants. Dividends were paid from 1905 to 1913 amounting to $1,529,500, and in 1913 the dividend amounted to $517,500.

The most important development for the year has been on the sixteenth level. * * * During the early months of 1913 all that remained of the profitable slag from the old Buffalo slag dump, amounting to approximately 5,000 tons, was cleaned up and shipped to the Old Dominion smelter. The shipments of siliceous ores to outside smelters were necessarily greatly reduced, owing to the absence of any profitable market at the present time for this class of ore, and the reconstruction of the Old Dominion concentrator reduced the facilities for concentrating the ore from the east end. The flow of water in the mine on the sixteenth level has remained practically constant throughout the year at approximately 650,000 gallons per 24 hours.

The Old Dominion and the United Globe mines, according to Douglas [2] are both confirming the indications of previous recent developments, which all point to the occurrence of oxidized and secondary ore bodies of large extent in depth, as far as yet explored below the 1,800-foot level.

Although the concentrator and crushing plant of the Old Dominion Co. is of comparatively recent date, improvements have followed one another so rapidly that changes in hoisting, in crushing, and in concentrating have necessitated a replacement of much old equipment by newer and better machinery.

There was produced from the Miami mine [3] concentrating ore aggregating 1,058,784 tons, which yielded 45,410 tons of concentrate containing 32,867,666 pounds of refined copper. The ore concentrated averaged 2.30 per cent of copper, and the concentrates recovered, 38.09 per cent of copper.

The ore extracted by stoping during the year is about equally divided between the shrinkage stopes in the northwest ore body and the square set and slicing work in the eastern part of the mine. The ore in the east ore body has now been mined down to the 370-foot level with the exception of the shaft pillar. A new slice has been

[1] United Globe Mines Ann. Rept. for year 1913.
[2] Douglas, James, Copper Metallurgy in Arizona in 1913: Eng. and Min. Journal, Jan. 10, 1914, p. 61.
[3] Miami Copper Co. Ann. Rept. for year ending Dec. 31, 1913.

started below the 370-foot level and slicing of the shaft pillar is in progress. The shrinkage stopes in the southwest and northwest parts of the ore body have been completely broken, and blasting of the pillars between the rooms has progressed to the point where drawing of the broken ore in these areas can soon be started. Development work on the 420-foot level and above was completed during the year in the older portion of the mine. The development of the Captain ore body, started in the previous year, is now well under way and actual mining operations in this section will begin during the current year. The sinking of the No. 1, or Captain, shaft to the 420-foot level was completed, thus furnishing an outlet from the mine to take the place of No. 2 shaft which has been lost as the result of mining operations. Development work on the 570-foot level was discontinued the latter part of the year, as the outline of the ore body at that level has now been well defined and actual mining need not begin for some time to come. * * * All six sections of the mill were in operation during the year, except at times of ore shortage during the second quarter of the year. * * * The results of milling operations for the year are as follows:

Operation of Miami Copper mine, Arizona, in 1913.

	Quantity.	Average of copper.	Cost of refined copper in concentrate f. o. b. cars at Miami, Ariz., in 1913.	
		Per cent.	*Per ton of ore.*	*Per pound of copper.*
Ore milled.....tons..	1,058,784	2.30	.....	.....
Concentrate produced.....do....	45,410	38.09	.....	.....
Copper in concentrate.....pounds..	[a] 34,597,568	.....	.....	.....
Copper recovered per ton of ore.....do....	32.68	.....	.....	.....
Mill extraction.....per cent..	71.60	.....	.....	.....
Mining.....	.....	.....	$1.6030	$0.05164
Milling.....	.....	.....	.5722	.01843
General.....	.....	.....	.2899	.00900
Total.....	.....	.....	2.4651	.07907

[a] Net smelter returns of refined copper was 32,867,666 pounds.

Exploration by churn drilling was continued, 2 old holes being completed and 13 additional ones being put down from the surface, the total number of feet drilled amounting to 8,774. * * * In the underground workings diamond drilling was continued, 2 old holes being completed and 7 new ones drilled, making a total depth of 1,757 feet. These holes, with the drifting done on the 570-foot level, furnished additional information regarding the extension of the ore body in depth. While no large additional tonnage was developed during the year, it is quite certain that the possibilities of ore below the 570-foot level have not yet been exhausted, and further work is being planned. On January 1, 1914, after allowing for ore extracted during the year, reserves are estimated at 20,300,000 tons, the average of all available samples showing a grade of 2.45 per cent copper. In making up the ore estimates in the past no account has been taken of oxidized ore. A considerable amount of this was known to exist, and on investigation we find that by drill holes and underground work there is indicated a body of mixed oxide and sulphide ore averaging about 2 per cent copper, containing 6,000,000 tons. The widespread revival of interest in the hydrometallurgy of copper unquestionably will result in the development of a process for the treatment of this ore, which should render it a valuable asset in the near future.

As the results of testing work, several car lots of copper concentrate were shipped from the Inspiration property.[1]

In January (1913) we began experimental running of our ore in a flotation unit of 50 tons daily capacity and continued such work until June following, with results that on the whole seemed favorable. During the latter part of 1913 we built a temporary crushing plant at the Scorpion shaft, and an experimental flotation plant of 600 tons' daily capacity on the benches of our mill site and alongside the location where our concentrator is building. This plant started on January 3, 1914, fed with ore taken from the development work of the mine. * * * At the time of the organization of the company it was proposed to provide for the daily treatment of 7,500 tons, but as work progressed it became apparent that larger operations would give

[1] Inspiration Consolidated Copper Co. Ann. Rept. for year ending Dec. 31, 1913.

better ultimate results to the stockholders, and it was therefore decided to enlarge the plant and bring the capacity up to 10,000 tons daily. * * * In the original exploration of the mine much copper-bearing material was discovered of a lower tenor than that reported as ore. Of this low-grade material the original churn drill records show 37,000,000 tons, assaying 1.26 per cent copper. The following tabulation covers the total development to the end of 1913:

Operations of Inspiration copper mine, Arizona, in 1913.

Classification of material.	Ore developed in original exploration.		Ore developed by drilling in 1913.		Ore originally developed but not reported.		Total.	
	Quantity.	Copper	Quantity.	Copper.	Quantity.	Copper.	Quantity.	Copper.
	Short tons.	*Per ct.*	*Short tons.*	*Per ct.*	*Short tons.*	*Per ct.*	*Short tons.*	*Per ct.*
Sulphide ore	45,000,000	2.00	.....	.....	.....	.....	45,000,000	2.00
Low-grade sulphide	.....	.....	2,839,000	1.45	25,483,000	1.24	28,322,000	1.26
Oxidized	.....	.....	3,767,000	1.33	8,678,000	1.34	12,445,000	1.34
Mixed carbonate and sulphide	.....	.....	252,000	1.53	3,624,000	1.22	3,876,000	1.24
Total	45,000,000	2.00	6,858,000	1.39	37,785,000	1.26	89,643,000	1.64

There were shipped from the Arizona Commercial [1] property 494 tons of ore averaging 3.58 per cent of copper taken out in doing development work. The property has been opened to the fourteenth level.

GREENLEE COUNTY.

Number of producers, quantity of ore sold or treated in Greenlee County, Ariz., in 1905–1913, and content in gold, silver, copper, and lead.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	
1905	[a] 9	952,509	$46,222	57,191	53,939,212	800,000	$8,532,882
1906	[a] 18	1,259,161	55,809	130,904	59,270,459	221,600	11,595,345
1907	[a] 35	1,418,499	[b] 30,513	[b] 87,578	62,720,962	14,142	12,633,256
1908	[a] 30	1,508,287	[b] 28,703	[b] 124,531	77,149,079	30,255	10,279,653
1909	[a] 25	1,566,989	[b] 38,682	[b] 88,082	71,826,650	44,729	9,423,873
1910	23	1,561,167	[b] 48,191	[b] 147,060	72,878,094	31,576	9,384,511
1911	23	1,551,220	31,541	104,429	70,926,330	30,734	8,954,062
1912	27	1,746,905	36,220	77,743	76,848,299	.....	12,764,001
1913	18	1,734,982	[b] 17,353	[b] 36,059	69,466,560	.....	10,806,450
Decrease (−) in 1913	.....	−11,923	−18,867	−41,684	−7,381,739	.....	−1,957,551

[a] Includes small district production from Graham County. [b] Includes small placer production.

Seventeen deep mine producers reported 1,734,982 tons of ore in 1913, which is 11,923 tons less than was reported by 27 deep mine producers in 1912. The total average value per ton decreased from $7.31 in 1912 to $6.23 in 1913. The value of the recoverable gold and silver is so small that it is not saved in the refining of the copper bullion, but is sufficient in the ore of one property to be reported. Hence, when the total tonnage of the county is used in arriving at the average value of the gold and silver it is shown to be only a few cents. The larger part of the ore produced was of concentrating grade and aggregated 1,494,447 tons, producing 190,232 tons of copper concentrate, which contained $3,891 in gold, 6,478 ounces of

[1] Arizona Commercial Mining Co. Ann. Rept. for year ending Dec. 31, 1913.

silver, and 51,398,077 pounds of copper, valued in all at $7,974,506, or an average value per ton of $41.92. The crude ore directly smelted aggregated 229,639 tons, containing $13,260 in gold, 29,579 ounces of silver, and 17,699,506 pounds of copper, valued in all at $2,774,549, or an average value per ton of $12.08. The greater part of the copper ore shipped to smelters was oxidized and aggregated 213,701 tons; the sulphide copper ores amounted to 14,845 tons. There were also 1,093 tons of siliceous ores, the larger part of which contained only gold and silver.

Copper Mountain and Greenlee districts.—The Detroit Copper Co. has extended its ownership over the properties of the Standard Copper Co. and the New England & Clifton Co., but, according to Douglas,[1] has not developed on either acquisition any ore bodies of significant value. The company is reported to recognize that it must rely upon ores of a lower grade in the future, and is making provisions to handle them economically. There were mined during the year 1913 from the Detroit [2] mines 533,563 tons of ore of all classes averaging 2.89 per cent of copper. The larger part, 518,718 tons, was of concentrating grade and averaged 2.78 per cent; smelting ore, 5,330 tons, averaged 11.80 per cent; quartz ore, 8,380 tons, averaged 3.23 per cent; and talc ore, 364 tons, averaged 5.73 per cent.

The Arizona Copper Co. has coupled up its large Coronado copper property with the Morenci claims by long tunnels, and thus is able to assemble its ores requiring concentration at one large mill at Morenci. The mines of the Arizona Copper Co.[3] yielded 34,230,000 pounds of Bessemer copper, as compared with 38,150,000 pounds in 1912, a decrease of 3,920,000 pounds.

This is partly accounted for by a lowering of the grade of ores mined, and by the delay in getting the new smelting plant up to capacity, which was started during the latter end of the period. The total ores mined from the company's properties during the year amounted to 936,903 dry tons, and the yield, as indicated by the smelter returns on ores treated, averaged 38.76 pounds of copper per ton of ore—a decrease of 2.39 pounds per ton as compared with the previous year. Of the total ores produced by the mines, 669,513 tons, or about 72 per cent, came from the Longfellow group, and 267,390 tons, or 28 per cent, came from the Metcalf group. About 95 per cent of the ores mined were concentrating ores, the remaining 5 per cent being direct smelting ores (including pyrites for the acid plant, and siliceous ores for converter flux.) * * * During the year 780,887 dry tons of sulphide concentrating ore were treated, of which 536,602 tons, or 68.7 per cent, were treated at No. 6 concentrator, and 244,285 tons, or 31.3 per cent, were treated at the Clifton concentrator. The average ratio of concentration was 7.26 tons of ore into 1 ton of concentrates. The work of enlarging the capacity of No. 6 concentrator and installing Hardinge conical mills for regrinding in place of the Huntington mills has been going on all year and has interfered materially with operation; this work is now well advanced and should be completed within a few months, when the capacity will be about 3,500 tons per day, more or less, according to the character of the ore. The Clifton sulphide concentrator has run steadily throughout the year, and treated 10,000 tons more ore than in the previous year. During the year the oxide concentrator treated 106,596 dry tons of ore, tailings from which amounting to 85,071 dry tons were treated by the leacher. From these ores 9.27 per cent of our total copper production was obtained. The sulphuric acid plant supplied the leacher with 3,352 tons of acid. During the year an average of 2.76 furnaces were in blast at the old smelter. A total of 151,265 tons of ores and concentrates were smelted. The average yield of copper from ores and concentrates smelted was 11.31 per cent. On account of the starting of the new smelting plant in August the old plant was gradually slowed down and finally closed completely on December 31.

[1] Douglas, James, Eng. and Min. Jour., Jan. 10, 1914, p. 61.
[2] Phelps, Dodge & Co. Ann. Rept. for year ending Dec. 31, 1913.
[3] Ann. Rept. for year ending Sept. 30, 1913.

The Shannon mines[1] and smelter produced during 16 months 18,793,724 pounds of copper, 169,197.52 ounces of silver, and 3,412.33 ounces of gold. A small tonnage of custom ores was treated, but was less than in former years.

For the fiscal year 1912–1913 we extracted from our mines at Metcalf 364,584.426 tons of ore, an average monthly output of 22,786 tons. The percentage of ores taken from open cuts showed a slight decrease, and a marked increase from our lower levels. The grade of ores from lower levels average slightly higher in copper contents than the average of the mine. * * * The company is still carrying on its leaching experiments, and, although we met with considerable encouragement, the process can not yet be considered commercially a success. * * * Leaching, in one form or another, is likely to become adaptable, not alone in treating the Shannon tailings (of which there are over a million tons carrying in excess of 20 pounds of copper to the ton), but also in treating at a profit, from one to two million pounds of semioxidized ore carrying 2 to 2½ per cent copper, which can be mined from the Shannon Hill at a very low cost.

MARICOPA COUNTY.

Twenty-one producers reported the output of 34,264 tons of ore, which is 14,141 tons greater than was produced by 9 operators in 1912. The total average value per ton of this ore increased from $16.48 in 1912 to $18.76 in 1913, and the gold and silver value from $15.66 to $17.91. Milling ores predominated, aggregating 33,230 tons and producing gold and silver bullion and lead concentrates, which contained a small quantity of copper and silver and good values in gold. There were shipped 259 tons of ore directly to smelters. The total value of the output amounted to $644,010, an increase of $310,938 over that of 1912. Placer production was reported from three sources and amounted to $1,068 in gold and 3 ounces of silver, as against an output in 1912 of $1,349 in gold and 11 ounces of silver.

Agua Fria district.—Bullion was recovered from tailings treated in a 50-ton cyanide plant on the Relief property. No ore was mined during the year.

Cave Creek district.—The district output, consisting of a small tonnage of ore and the production of placer bullion reported from one source, amounted to $846, as against the yield of ore and bullion valued at $1,423 in 1912.

Magazine district.—The Red Rover property produced copper oxidized ore, containing silver. This property is opened by an incline shaft 370 feet deep, and the ore produced is hauled to Phoenix and shipped from there to the smelter.

Salt River district.—The Max Delta Gold Mining Co., situated 9 miles southwest of Phoenix, shipped to the smelter a car of gold ore containing a little silver and a trace of copper. The property is opened by an incline shaft sunk 400 feet.

San Domingo district.—An output valued at $1,401 was produced from deep mines and placers.

Vulture district.—In 1913 the Vulture mine continued as the largest producer, yielding ores containing gold, silver, copper, and lead. The last two metals were contained in the concentrate, and the largest part of the gold values was recovered in bullion. The property was operated the entire year. There were a number of other small pro-

[1] Shannon Copper Co. Rept. for 16 months ending Dec. 31, 1913.

ductions from the district. Wood[1] gives an account of mining and milling as practiced at the Vulture property:

The property of the Vulture Mines Co. is about 15 miles southwest of Wickenburg, Ariz. The holdings consist of 20 claims, a well-equipped mill, and all the necessary paraphernalia for operating a modern mine. About 500 people make their homes at the mines, and approximately 200 men are on the payroll of the company. The original location was made about 1863 by John Wickenburg, who founded the town of Wickenburg and gave it his name. Mr. Wickenburg and others mined the rich oxidized ore from near the surface and hauled it to mills on the Hassayampa River, where the gold was extracted to the satisfaction and enrichment of the owners. This kind of work was continued until 1880.

In 1881 an 80-stamp mill was built on the property by George B. Treadwell and associates. The stamps weighed about 750 pounds each. All the machinery for this mill was hauled to the mine from Ehrenburg, on the Colorado River, a distance of about 100 miles. The treatment was by amalgamation. A large tonnage of tailing was produced, about 30,000 tons of which was leached by a succeeding management at a supposedly good profit. The present management acquired the property in September, 1908. Twenty stamps in the old mill were put into commission and run for about a year, in order to arrive at definite conclusions as to the proper treatment for the ore and the kind of mill to erect. The new mill was erected in 1910 and placed in operation in September of that year, the use of the old mill being totally discontinued. The new mill consists of 20 stamps of 1,650 pounds each, with a capacity of 100 tons per 24 hours when crushing to 40 mesh. Amalgamation is effected inside the mortars, the ore being crushed in a cyanide solution. Both sand and slime are concentrated, 4 Wilfley and 3 Deister tables being used. The tailing from the tables is sent to the cyanide tanks, consisting of 4 large Dorr thickeners. The gold is precipitated by the Merrill zinc-dust process. The concentrate is shipped to the El Paso smelter for final treatment. The regular mill feed will average about $20 per ton in gold, and the saving is effected approximately as follows: Amalgamation, 60 per cent; concentration, 20 per cent; and cyanidation, 20 per cent. The greater portion of the fuel used is crude oil and distillate. Six-ton motor trucks are used to haul the fuel oils, and are loaded with concentrate on the return trip. Haulage expense has been reduced about 50 per cent by the use of the truck in place of teams. The trucks use distillate for power. The main working shaft is 750 feet deep in a 40-degree incline. It is a single compartment with two skip tracks. Because of faulting in the ore body, the present workings are about 400 feet east of the main working shaft. There are about 3 miles of underground work. The main working shaft is timbered throughout with 8 by 8 inch square sets, being 5½ by 10 feet in the clear. The ground is good and easily held, no trouble having been experienced in the shaft for several years. The hoisting equipment consists of an Ottumwa double-drum steam hoist, handling skips of 1-ton capacity, which dump automatically into bins. The ore is then trammed by hand to the crusher bins, about 150 feet distant. From there it goes through a No. 5 Gates crusher, which reduces it to 2-inch size. It is then elevated on a Robbins belt conveyor to the fine ore bin, from which it is sent by a 4-ton rope skip to mill bins, from which it is fed by gravity to the stamps. Development work is being pushed eastward and vertically below the 1,000-foot level, keeping the ore reserves well in advance of mill requirements. The ore is principally white quartz carrying galena and iron pyrites. The method of mining consists of breast stoping and back-filling. The power plant consists of two 500-foot Sullivan power compressors, driven by two 150-horsepower Nash gas engines, using distillate as fuel, and two 300-foot Sullivan steam compressors. The power for operating the stamp mill is also supplied by two 150-horsepower Nash gas engines. The water supply for camp purposes and the boilers comes from a 1,000-foot well, while water for the mill is pumped from the mine, which furnishes an adequate supply.

White Picacho district.—The output credited to this district in 1913 amounted to 32 tons of copper ore, the yield of four producers. Development work was carried on at the Arizona Vermont property, and a small test shipment was made from the Orion property.

[1] Wood, W. M., Mining and milling at the Vulture property: Min. and Sci. Press, Dec. 27, 1913, p. 1018.

MOHAVE COUNTY.

Number of producers, quantity of ore sold or treated in Mohave County, Ariz., in 1904–1913, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	13	47,520	$563,824	86,782	1,420	6,036	.....	$613,95
1905	21	52,712	543,090	73,536	30,399	112,266	.....	597,52
1906	27	64,832	641,034	145,179	315,992	904,399	.....	850,84
1907	49	68,887	585,383	80,897	601,210	1,229,654	.....	825,99
1908	42	76,708	295,736	39,427	345,491	254,013	505,133	396,64
1909	30	30,822	[a] 356,363	[a] 79,662	313,384	113,406	5,264,121	727,66
1910	40	99,283	1,145,022	112,445	529,753	740,091	5,474,046	1,601,18
1911	47	140,402	1,547,663	143,969	244,378	2,591,589	4,476,552	2,026,30
1912	40	202,937	[a] 1,899,131	[a] 174,343	644,145	1,937,031	8,304,462	2,772,81
1913	44	206,239	1,874,547	246,702	747,620	5,315,646	7,031,400	2,767,08
Increase (+) or decrease (−) in 1913.		+3,302	−24,584	+72,359	+103,475	+3,378,615	−1,273,062	−5,72

[a] Includes small placer production.

The output of 206,239 tons of ore made by 44 producers in 1913 was 3,302 tons greater than that from 39 producers in 1912. The total average value per ton of this ore decreased from $13.66 to $13.42, and the gold and silver value from $9.89 to $9.81 per ton. The total value of the ore produced amounted to $2,767,083, or $5,727 less than the value of the output of 1912. The total gold produced in 1913 amounted to $1,874,547, as against $1,899,131 in 1912. The silver yield increased in value from $107,221 to $149,008; copper, from $106,284 to $115,881; lead, from $87,166 to $233,889. Zinc decreased from $573,008 in 1912 to $393,758 in 1913. The larger part of the ore was treated at milling plants by cyanidation and concentration. At gold and silver mills seven producers treated 235 tons of ore by amalgamation, yielding 182.75 ounces of gold and 118 ounces of silver. The production of cyanide precipitates and gold bullion made by seven producers treating 160,556 tons of ore aggregated 87,073.05 ounces of gold and 41,189 ounces of silver. The concentrating ores, aggregating 35,145 tons, yielded 17,536 tons of concentrate, containing $52,183 in gold, 133,329 ounces of silver, 18,425 pounds of copper, 4,943,909 pounds of lead, and 6,098,814 pounds of zinc, valued in all at $694,635, or an average value per ton of $39.61. The crude ore shipped to smelters aggregated 4,856 tons, yielding $18,627 in gold, 72,066 ounces of silver, 729,195 pounds of copper, 371,737 pounds of lead, and 932,586 pounds of zinc, valued in all at $243,762, or an average value per ton of $50.20.

Aubrey district.—The Midas claim yielded a small quantity of gold and silver bullion. The property is equipped with a 5-stamp mill, operated by a gasoline engine.

Bentley district.—Shipments of copper oxidized ore from the Mohave, Savanic, and Grand Gulch properties aggregated 1,982 tons. The Grand Gulch mining district is described by Hill.[1] The mines were examined in November, 1913.

The district is most easily reached from Moapa, Nev., on the main line of the San Pedro, Los Angeles & Salt Lake Railroad, and 28 miles northwest of St. Thomas, Nev., the supply point for part of southeastern Nevada and northern Arizona. The climate is

[1] Hill, James M., The Grand Gulch mining region, Mohave County, Ariz.: U. S. Geol. Survey, Bull. 580, pp. 39–58, 1914.

typical desert weather, and there is a fair quantity of timber available. The Grand Gulch mine is 54 miles east of St. Thomas. It has been developed by a shaft 500 feet deep, and levels have been driven at 100, 200, 300, and 400 feet. Owing to the peculiar shape of the ore body the levels are generally of circular plan. At 200 feet the ore zone is about 300 feet in diameter. In the upper portion of the mine the ore is in sandstone, in the lower portion in limestone. The ore consists largely of malachite, azurite, and brochantite, with irregular masses of chalcocite scattered through it. The ore does not extend below a depth of about 250 feet, there being no copper minerals at 300 or 400 feet. The copper was deposited in the upper workings by generally downward-moving waters. Fifty men were employed in the fall of 1913. The Bronze L. mine is 3 miles southwest of the Grand Gulch, and has been opened by a 200-foot incline shaft, now caved to about 100 feet. The ore minerals are largely sulphides, with smaller amounts of azurite and malachite. The Copper King mine is 40 miles east of the Grand Gulch mine, near the Colorado River. Every two months a carload of 23 to 26 per cent copper and $3 to $4 silver ore is shipped by Bishop Whitehead.

Cedar Valley district.—Gold bullion and a small quantity of ore carrying traces of lead and copper were shipped from the district in 1913 from three properties. The total product was valued at $532.

Chemehuevis district.—The production of a small quantity of ore, carrying principally gold values from the Tip Top property, is credited to this as the nearest district. The group of claims is situated 5 miles south of Powell.

Cottonwood district.—The principal producers in 1913 were the Copper Giant and Walkover properties, which yielded ore containing values principally in gold and a small quantity of silver and copper.

Gold Basin district.—Gold ore was mined from the Cyclopic claim and treated by cyanidation in a 20-ton plant connected with the property. The gold precipitates produced were shipped to the smelter for refining.

Owens district.—The output credited to this district, produced from two properties, consisted of mill bullion and a small tonnage of ore containing lead, silver, and a trace of gold and copper.

San Francisco district.—Gold and silver bullion extracted by cyanidation from the ores of 5 properties aggregated $1,818,522. The principal producers were the Tom Reed and Gold Road mines, and smaller productions were made from the Gold Crown and Arabian properties. Altogether there were treated 159,948 tons of ore, from which was recovered an average of $11.37 per ton in gold and silver.

The Tom Reed mine[1] produced in its fiscal year 48,110 tons of ore, averaging $24.09 per ton in gold and silver, against 43,478 tons valued at $23.22 per ton in 1912. The gold and silver bullion recovered in 1913 was valued at $1,141,907.27, as against $1,126,244.95 in 1912. Dividends amounting to $618,497 were paid in 1913, making a total of $1,882,864 distributed during a period of four years. Since production began six years ago, $4,051,215 has been received for the yield of gold and silver. In 1912 a system of "farming the tailings" was begun and resulted in saving additional values. This system was continued in 1913, and consists in flooding the tailings in ponds where, by the sun's rays, the moisture is evaporated, and the dry surface is then swept into piles. The sweepings are periodically returned to cyanide tanks for retreatment.

The Gold Road mine[2] produced 103,629 tons of ore, which was treated at its cyanide plant. The grade of the ore continued low, leaving only a small margin of profit.

[1] Tom Reed Gold Mines Co. Ann. Rept. for year ending Apr. 1, 1914.
[2] United States Smelting & Refining Co. Eighth Ann. Rept. for year ending Dec. 31, 1913.

Development work yielded some ore of better grade, but the general average was rather low. Development work is being done on the extension of the vein with the hope of finding ore of better grade. It may be found advisable to sink the shaft 300 feet in order to explore the vein at greater depth. Various improvements were made in the mill, and the operation of the plant was very satisfactory.

Wallapai district.—The output of the Golconda property, situated at Union Basin, is included in the total production of this district, which in 1913 yielded 42,967 tons of ore by 22 producers. There was recovered from this ore $70,224 in gold, 202,282 ounces of silver, 31,072 pounds of copper, 5,312,754 pounds of lead, and 7,031,400 pounds of zinc, valued in all at $824,738. The Golconda concentrating mill was operated about seven months, and the zinc sulphide concentrates were mixed with some crude ore before shipment to the smelter. Other properties having important productions were the Tennessee and Rainbow mines.

The smelter [1] at Needles, Cal., was run during a short period of the year. The mill, however, operated throughout the year. A small tonnage of custom ore was received, but the main supply of ore came from the Tennessee mine, at Chloride, which is operated under lease and bond by the Needles Co. A good tonnage of ore was developed in the Tennessee mine above the 900-foot level of high enough grade to yield a fair profit. Much better results would have been accomplished had not the prices of lead and zinc been so very low. Preparations are now being made to sink an interior shaft from the 900-foot level to make available the ore body below this level.

Weaver district.—Gold and silver bullion was recovered from ores of the Mocking Bird and Utah-Arizona properties. Nothing more than assessment work was carried on at either property.

PIMA COUNTY.

In 1913 the total output of the county, made by 45 producers, was valued at $435,887, an increase of $40,505 over the production of 1912. The total output in 1913 includes $3,694 in gold from deep mines and $8,391 in gold from placers, 64,477 ounces of silver, 1,425,930 pounds of copper, 1,015,803 pounds of lead, and zinc ore containing 2,127,568 pounds of spelter. Almost the entire ore production, or 21,925 tons, was shipped directly to the smelters. Only 441 tons of ore were concentrated, yielding 147 tons of lead concentrates.

Amole district.—Two small productions of copper ore carrying a little silver were reported.

The Calumet & Arizona Mining Co.[2] secured an option on the Amole copper property, which consists of 17 unpatented claims, and is located in central Pima County, Ariz., 9 miles south of Tucson and about 7 miles from the nearest point on the El Paso & Southwestern Railroad. On this property several shafts, from 180 to 300 feet deep, have been sunk to develop gold-bearing veins in shale and limestone. These shafts are now partly filled with water and are inaccessible, but it is claimed that considerable stoping was done on veins from 3 to 6 feet wide, assaying from $10 to $20 in gold. The mineralization in this property is of the same character as that at Ajo, though not quite so strong. This property will be systematically developed by diamond drilling.

Ajo district.—The property of the New Cornelia Copper Co. was purchased by the Calumet & Arizona Mining Co.[1], and from careful drill sampling the estimated results show 40,258,000 tons of carbonate and sulphide ore, averaging 1.51 per cent of copper. Of this,

[1] United States Smelting & Refining Co. Eighth Ann. Rept. for year ending Dec. 31, 1913.
[2] Ann. Rept. for year ending Dec. 31, 1913.

there is available to steam shovel 32,481,200 tons averaging 1.54 per cent of copper, and of sulphide ore not available to steam shovel 7,776,800 tons averaging 1.40 per cent of copper. Of rock stripping in carbonate and in sulphide zones there is estimated 3,308,400 tons, which will average about 0.64 per cent of copper.

Exhaustive work has been done during the past year to check the grade of ore at Ajo obtained by sampling the material from the extensive system of drill holes previously sunk. Test shafts were sunk on alternate drill holes to water level. Two shafts were sunk to greater depth and about 1,500 feet of drifting was done from these shafts to test the grade of sulphide ores. All material coming from shafts and drifts was sampled and afterwards most careful hand sampling was done in all the openings. * * * Two wells have been drilled to date and a third has been started to develop water in the broad desert valley immediately below the mines. In the first well water has been encountered apparently in quantity, but the available supply can not be determined until a high-pressure air plant is installed at this well to make a definite test of long duration by raising the water with an air lift. The water was encountered at between 500 and 700 feet from surface. There is water available in abundance, but it is at farther distance from the mines. The minimum requirements for water are about 500 gallons per minute.

On July 23 a railroad engineering crew was put in the field to make a preliminary survey and estimate of cost of constructing a railroad from Tucson to Ajo, which would connect with the El Paso & Southwestern and Southern Pacific railroads at Tucson, and from Ajo northward, which would connect with the latter railroad in the vicinity of Gila Bend. This work was completed on December 22. Both routes were found feasible with grades not to exceed 1 per cent and curvatures not in excess of 3 degrees.

The carbonate ores, which form about 25 per cent of the total tonnage developed, will be leached. The copper may be precipitated from solution by metallic iron and produced commercially at a reasonable cost, but we are experimenting with a different method of precipitating the copper, which, if successful, will result in a great saving in cost over precipitating with iron and will also in a large part regenerate the acid used in leaching. If this method proves practicable it will, of course, supplant our present plan of precipitating with iron. From actual experiments by flotation methods, our sulphide ores are found to yield a splendid recovery, and we feel that a very high saving can be made on this class of ore, if we decide to use a flotation process. Work for the past year has demonstrated the fact that the company, in its purchase of the New Cornelia property at Ajo, has secured one of the great low-grade porphyry mines, which will be a source of long-continued revenue to its stockholders.

Arivaca district.—Lead ore carrying silver and a small quantity of gold and a trace of copper was produced from the Highland Mary property. Similar ore was also shipped from another claim, the name of which was not reported.

Bavoquivari district.—Five producers reported the output of 331 tons of ore containing principally copper with gold, silver, and a small quantity of lead, valued in all at $14,309. Among the producers was the Gold Bullion property, yielding siliceous gold and silver ore. Some ore was also reported as shipped from the Papago property.

Greaterville district.—The district output in 1913 amounted to $3,495, consisting principally of placer gold taken out by transient operators using rockers and dry washers.

Helvetia district.—During 1913 there were 739 tons of ore produced containing $64 in gold, 1,170 ounces of silver, 62,805 pounds of copper, 10,392 pounds of lead, and 236,117 pounds of zinc, valued in all at $24,185, or an average value per ton of $32.73. Oxidized zinc ore was produced from the Rosemont, and Spokane-Arizona properties. Copper ore was produced from the Tip Top, Rosemont, Naragansett, and Cuprite properties.

Pima district.—Fifteen deep mine producers reported a production of 20,555 tons of ore, containing $305 in gold, 51,765 ounces of

silver, 1,217,188 pounds of copper, 997,813 pounds of lead, and 1,891,451 pounds of zinc, valued in all at $370,060, or an average value per ton of $18. All of the zinc ore produced in the district was shipped to eastern plants, and the copper ores were shipped to Douglas. The Pioneer smelter, at Corwin, treated only a small tonnage, closing its property early in the year. All of the lead ores were shipped to El Paso. The largest producers of lead ore and zinc carbonate ore were the San Xavier and Twin Butte properties. Copper ore was shipped from the Plumed Knight and lead ore from the Rich Hill property.

The mine developments of the district[1] became quite important in 1913, and the most interesting development was that of the Empire Zinc Co. in exposing an important ore body between the 200 and 300 foot levels of the San Xavier mine, which the company bought late in 1912. About 60 men were employed and 1,500 tons of copper-silver-lead ore were shipped monthly to the El Paso Smelting Works, the ore being hauled 7 miles to Sahuarita by two 6½-ton Saurer motor trucks. A third Saurer truck was ordered late in 1913. Besides the above shipments the company has been blocking out the blende ore, which will not be stoped until a suitable concentrator is erected. In July, 1913, E. G. Bush leased the Morgan mine of the Twin Buttes Mining & Smelting Co. and shipped about 1,000 tons monthly to the Copper Queen smelting works. The ore is high in iron and desirable for fluxing purposes. The Copper Glance mine, of the Twin Buttes Co., was developed on company account, and in a winze sunk 30 feet below the 400-foot level a body of rich sulphide ore was exposed for 20 feet. The width of the ore body was not known, as neither wall was in sight when operations had to be abandoned because of a large flow of water. The company expects to complete the raising of the new vertical shaft from the 400-foot level, after which suitable pumping machinery will be installed to explore the new ore body.

The Tucson Mining Co. built at Olive a 100-ton concentrator to treat the silver-lead ore of that camp, the principal ore supply being from the Wedge and Swastika mines. Kidney pneumatic jigs are included in the equipment of this mill.

The Chesterfield Copper Co. completed during the year the sinking of a 2-compartment shaft to the 800-foot level, drifts from which are being run to find the high-grade ore shoots worked in the upper levels.

Quijotoa district.—The Matt Perry group, equipped with an amalgamation and concentration mill of 15 tons daily capacity, was operated a short time in 1913, producing lead, gold, and silver.

Redington district.—Near Winkelman the Sango property produced copper ore carrying a small quantity of silver obtained from the surface.

Silver Bell district.—Three producers reported the production of 610 tons of oxidized ore carrying silver. It had a total value of $13,802.

PINAL COUNTY.

Eighteen deep-mine producers reported the output of 2,378,823 tons of ore. This is 801,612 tons more than was supplied by 15 producers in 1912. The total value of the ore decreased slightly from $3.95 to $3.72 per ton, and the gold and silver in this ore increased from 5 cents to 7 cents. The bulk of the county output is from one property at Ray. The larger part of the tonnage, or 2,371,468 tons, was treated at concentration mills, yielding 145,678 tons of concentrates, valued at $8,471,872, or an average gross value per ton of $58.15, of which the larger part was for copper. The ores shipped directly to smelters aggregated 7,051 tons, valued at $362,943, or an average value per ton of $51.47. Of the crude ore shipped to smelters, 6,567 tons were copper sulphides, and 447 tons were oxidized copper ore.

[1] Arizona in 1913: Eng. and Min. Jour., Jan. 10, 1914, p. 123.

Only 9 tons of sulphide lead ore were shipped in 1913. At gold and silver mills 304 tons of siliceous ore yielded $3,894 in gold and silver. Placer bullion amounting to $1,106 in gold and 8 ounces of silver was produced in 1913, against $789 in gold and 6 ounces of silver in 1912.

Bunker Hill district.—Copper concentrates containing a small quantity of silver were produced as the result of ore treated in the partial operation of the 180-ton concentration mill of the Calumet & Copper Creek Mining Co. These concentrates were from ore produced from the Old Reliable property. It is reported that the mine is gradually being put in condition for steady production.

Casa Grande district.—Ores carrying copper and a little silver and gold were produced from the property of the Reward Mining Co. and shipped directly to the smelters. The ore was taken out in doing assessment work.

Goldfields district.—The 10-stamp mill and the 50-ton cyanide plant of the Mammoth group were operated a short time in 1913 and yielded a small quantity of gold and silver bullion.

Mineral Creek or Ray district.—All of the ore produced in the district was from one property—the Ray mines—which produced 2,367,400 tons. All of this was shipped to Hayden and concentrated in the company's mill. The concentrates, with a small quantity of crude ore, were treated at the Hayden smelter.

In 1913 there was produced from the Ray mines [1] 2,365,296 tons of milling ore, corresponding to a daily average of 6,480 tons treated at the concentration mill. Copper concentrate was produced containing an average of 18.55 per cent of copper. Crude ore shipped directly to the smelter contained 412,372 pounds of copper, bringing the total gross production from all sources to 54,148,309 pounds. The total tonnage of ore treated since the beginning of operations to the end of the year 1913 was 4,612,691 tons. The average copper content of the ore treated for 1913 was 1.719 per cent, as compared with 1.677 per cent for 1912. The average recovery for the year, based on the total copper contained in concentrates produced, was 66.09 per cent, corresponding to 22.723 pounds of copper per ton of ore, as compared to 22.9 pounds for the previous year. The recoveries of the year were affected adversely by a considerable amount of oxidized ore coming at times from upper levels, and also by the irregular operations of the mill during the last half of the year, when improvements were in progress. * * * The developed tonnage, as stated in the last annual report, after deducting the tonnage mined up to the end of the year 1912, was 80,656,973 tons, averaging 2.2 per cent copper, this tonnage underlying an area of 205.2 acres. Adding the 90,000 tons referred to above to the total tonnage last stated gives a total of 80,746,973 tons, without materially changing the average percentage of copper. During the year's operations there was mined, including a small tonnage of ore shipped direct to the smelter, a total of 2,366,007 tons averaging 1.72 per cent copper. The total developed tonnage remaining is, therefore, 78,380,966 tons. The total tonnage mined from the beginning of operations up to the end of the year 1913 was 4,613,402 tons. * * * The total development of the year in the territories served by all of the three shafts was 84,729 feet, a reduction of about 40 per cent as compared to this class of development for the year 1912. The total underground development for the full period of operations up to the end of 1913 was approximately 377,000 feet, or about 71 miles. * * * At the beginning of the year 6 sections of the mill were completed and in operation. The seventh section was completed in January and operated intermittently, as needed, the mine being unable to supply continuous tonnage for more than 6 sections at that time. The eighth and last section of the mill was completed and started up in October. Since that time all sections have been operated as required, and at the end of the year were handling nearly their rated capacity of 1,000 tons per section per day, or 8,000 tons per day for the completed plant. * * * The cost of milling for the year was 51.93 cents per ton, as compared to 46.88 cents per ton for the previous year. * * * The cost of mining ore from all sources for the year was 73.23 cents per ton as compared with 77.55 cents per ton for the year 1912.

[1] Ray Consolidated Copper Co. Ann. Rept. for year ending Dec. 31, 1913.

Old Hat district.—In 1913 the output of one placer and one deep mine aggregated $887, against an output of $8,869 in 1912.

Pioneer and Silver King districts.—Crude copper ore was shipped principally from the property of the Magma Copper Co. in 1913. This ore carried from 13 to 51 per cent copper and from 15 to 91 ounces of silver, the highest content of a carload was 104 ounces. The gold content averaged from 60 cents to $2 per ton.

The Calumet & Arizona Mining Co.[1] continued exploration and completed early in 1913 its high-tension electric-power line from Ray to the Tener shaft on the Daggs-Newman group of claims. Electric hoist, compressor, drill sharpener, and pumps were installed. The Tener 3-compartment shaft was sunk and timbered to a depth of 730 feet.

Riverside district.—The production of 556 tons of ore from 5 deep mines was largely of shipping grade and contained 463 ounces of silver and 77,371 pounds of copper. A small lot of ore was treated in an arrastre, yielding gold bullion. The total value of the district output, including placers, was $12,717. The producers were the Kelvin-Sultana, shipping sulphide and oxidized ores, and the Renfro and Fry groups, yielding copper oxidized ore.

Saddle Mountain district.—The Hoosier group yielded a small quantity of copper oxidized and sulphide ore containing good values in gold and a little silver.

SANTA CRUZ COUNTY.

Forty deep mine producers reported the production of 22,662 tons of ore. This is 8,380 tons greater than was produced by 30 producers in 1912. The total average value per ton increased from $27.68 in 1912 to $31.26 in 1913, but the gold and silver value in this ore decreased from $5.04 to $2.76 per ton. The total value of the county output amounted to $708,356, of which the gold was valued at $26,478; silver, 59,834 ounces, valued at $36,140; copper, 4,012,238 pounds, valued at $621,911; and lead, 541,522 pounds, valued at $23,827. The bulk of the ore was shipped directly to the smelters, aggregating 22,232 tons, valued at $695,725, or an average value per ton of $31.29. The ore to gold and silver mills, of which there were 349 tons treated, yielded $7,518 in gold and 177 ounces of silver. There was no placer production reported.

Harshaw district.—There were 419 tons of ore produced by 5 operators, carrying gold, silver, copper, and lead. The total value of the output amounted to $28,899, or an average value of $68.97 per ton.

Oro Blanco district.—Ore was produced from the Austerlitz property, part of which was shipped crude, and part treated in a mill, yielding concentrate containing gold and silver with a little copper and lead. At the Gold Bullion mill there was treated by amalgamation an important tonnage of ore yielding gold and silver bullion. These properties, with the Monarch and five others, yielded 493 tons of ore, from which was recovered gold, silver, copper, and lead amounting in value to $14,497.

Palmetto district.—All of the ore produced in the district in 1913 was of shipping grade and aggregated 16,623 tons, containing $2,091

[1] Ann. Rept. for year ending Dec. 31, 1914.

in gold, 6,972 ounces of silver, 2,995,289 pounds of copper, and 1,881 pounds of lead, valued in all at $470,655, or an average value per ton of $28.31. The Three R. property was the principal producer of copper sulphide ore.

Patagonia district.—The ores produced in 1913 were sulphide copper ores of shipping grade, being mined principally from the Duquesne property and a small quantity from the Morning Glory claims.

Tyndall district.—All of the ore produced from 10 properties was of shipping grade and aggregated 891 tons, containing $1,219 in gold, 6,115 ounces of silver, 67,918 pounds of copper, and 368,616 pounds of lead, valued in all at $31,660, or an average value per ton of $35.53. The principal producers were the Isabella, Connecticut, Eureka, Rosario, and Royal Blue properties.

Wrightson district.—The Blue Lead, American Boy, Eldorado, and three other properties were producers of 286 tons of ore, carrying $515 in gold, 4,748 ounces of silver, 9,863 pounds of copper, and 91,219 pounds of lead, valued in all at $8,925, or an average value per ton of $31.21.

YAVAPAI COUNTY.

Number of producers, quantity of ore sold or treated in Yavapai County, Ariz., in 1904–1913, and content in gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*F. ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	34	439,622	$2,013,747	953,622	30,826,286	497,905	.....	$6,436,105
1905	39	364,697	1,391,070	786,707	34,279,734	697,806	.....	7,259,097
1906	46	396,788	1,256,623	708,439	42,080,740	729,787	.....	9,894,458
1907	117	375,398	1,144,102	647,488	35,734,416	521,307	140,786	8,754,263
1908	79	314,113	1,116,793	602,645	36,248,440	362,334	.....	6,236,207
1909	56	323,489	952,243	578,580	37,125,964	409,890	.....	6,097,105
1910	104	417,308	881,970	669,702	40,824,556	264,911	.....	6,456,184
1911	109	245,165	689,684	764,744	36,103,649	318,089	47,165	5,624,956
1912	108	406,053	482,501	748,872	34,043,005	481,827	292,705	6,602,032
1913	105	447,659	517,216	854,049	38,719,973	242,369	211,533	7,057,167
Increase (+) or decrease (−) in 1913	.....	+41,606	+34,715	+105,177	+4,676,968	−239,458	−81,172	+455,135

[a] Placer production included.

The output produced by 92 deep mines and from 13 placers was valued at $7,057,167. The deep mines produced 447,659 tons of ore, which was 41,606 tons more than was mined by 93 producers in 1912. Of the total value of metals recovered, $517,216 was for gold, $515,845 for silver, $6,001,596 for copper, $10,664 for lead, and $11,846 for zinc. The production of gold, silver, and copper increased, but the lead and zinc output decreased. The total average value per ton decreased from $16.22 in 1912 to $15.74 in 1913, and the gold and silver in this ore remained the same as in 1912, $2.28 per ton. There were 412,789 tons of ore treated at smelters, the larger part of which, or 411,657 tons, was copper ore, of which 411,356 tons were sulphide ore. There were 402 tons of siliceous ore produced, and 431 tons of lead ore, the larger part of which (396 tons) was sulphide ore. The total value of these ores treated at smelters amounted to $6,775,087, or an average value per ton of $16.41. At concentration mills the ore treated aggregated 28,794 tons, which produced 9,201 tons of concentrates containing $19,001

in gold, 20,777 ounces of silver, 1,365,079 pounds of copper, 4,478 pounds of lead, and 57,160 pounds of zinc, valued in all at $246,538, or an average value per ton of $26.79. The ores treated at gold and silver mills aggregated 2,032 tons, which produced $16,139 in gold and 359 ounces of silver. The placer output amounted to $10,210 in gold and 103 ounces of silver, as against a production of $15,923 in gold and 130 ounces of silver in 1912.

Agua Fria district.—One producer of oxidized ore containing principally copper made shipments to the local smelters and another property produced a little siliceous ore.

Big Bug district.—There were 20 producers reporting the production of 38,817 tons of ore. The Blue Bell mine produced the largest quantity of ore, which was shipped to Humboldt. This yielded copper concentrate, which was smelted. The mines of the district produced 8,911 tons of crude ore, which was directly smelted and contained 589.47 ounces of gold, 17,734 ounces of silver, 623,426 pounds of copper, and 15,406 pounds of lead. Old tailings were also shipped from the Henrietta dump to the smelters and contained principally gold and silver. There was also an important tonnage of old tailings smelted from the Blue Bell mill dump. At gold and silver mills 274 tons of ore yielded a small quantity of gold and silver bullion. Aside from the properties already mentioned, the other principal producers were the Gladstone & McCabe, Humboldt Consolidated, Independence, and Leland. The Poland mill at Poland was operated by lessees on ore from the Walker district. Three placers produced $2,354 in gold and 25 ounces of silver.

Black Canyon district.—Three properties produced 61 tons of ore, yielding gold, silver, and lead valued at $3,990, or an average per ton of $65.41. This ore was taken out principally in doing assessment work.

Black Hills district.—A carload of oxidized copper ore was shipped from one property in the district.

Black Rock district.—A copper oxidized ore containing gold and silver was shipped from the Big Blue property, which is equipped with a concentrating mill of 40 tons' daily capacity recently completed. The plant was not ready for operation in 1913.

Blue Tank district.—In doing assessment work the Great Northern property yielded a small tonnage of oxidized copper ore carrying gold and a little silver.

Cherry Creek district.—The Etta property and the Little Johnny were each productive of a small quantity of ore containing principally gold and a little silver.

Copper Basin district.—An important tonnage of copper sulphide ore was shipped from the Copper Basin and Senator properties.

Copper Mountain district.—The Horse Shoe and Half Moon properties, situated 4 miles east of Mayer, yielded oxidized copper ore carrying good values in gold and silver.

Eureka district.—Ore produced from the Great Western, Nieman, and Cyglance properties yielded some bullion and also cyanide precipitates.

Hassayampa district.—The output of 15 producers aggregated 1,646 tons of ore, the larger part of which, aggregating 882 tons, was shipped to the smelters and yielded 459.84 ounces of gold, 18,295 ounces of silver, 80,173 pounds of copper, 102,573 pounds of lead, and 117,227

pounds of zinc. The largest producers were the Climax and Ruth properties, and an important tonnage was mined from the Davis group of the Lookout Copper Co. At gold and silver mills 764 tons of ore yielded 189.98 ounces of gold and 57 ounces of silver. The Y. P. mine, formerly the Cash, shipped to the smelter one lot of lead ore carrying silver, gold, and copper. Other important producers were the Emporia, McNulty, and Dunkirk properties.

Humbug district.—Seven producers mined 304 tons of ore. The largest part, or 266 tons, yielded 90.64 ounces of gold, 48 ounces of silver, and 21 tons of sulphide concentrate carrying gold, silver, and a trace of copper. There were also shipped directly to the smelter 38 tons of ore carrying a small quantity of gold and silver. The principal production of mill ore was mined from the Occident group. There was also some gold and silver bullion and concentrates produced from the ores of the Olympia and Klondyke claims, which were operated about five months during the year. A small tonnage of siliceous ore was milled from the Golconda property.

Peck district.—Mixed oxidized and sulphide lead ore, carrying silver and a little copper and gold, and some siliceous silver ore was shipped from the Silver Prince property, which is opened by a vertical shaft 420 feet deep and has 1,400 feet of drifts. The Lincoln mill was cleaned up, which resulted in a small shipment of concentrate carrying gold, silver, and a trace of copper.

Pine Grove and Tiger districts.—Milling ore yielding concentrates and bullion containing gold and silver was produced from ore treated in a 5-stamp mill from the Saratoga property. Zinc concentrates containing copper, a little lead, silver, and gold, were reconcentrated from an important tonnage of old tailings in the mill at Crown King. The Tiger Gold Co. did not produce in 1913.

Turkey Creek district.—The tonnage of ore from the district aggregated 23 tons and yielded principally gold and silver. The total output, including that of 1 placer, was valued at $2,079. The largest producer was the Thunderbolt property.

Verde district.—The larger part of the district output was from the United Verde mines, which, with a small tonnage of sulphide ore from the Cleopatra property, aggregated 393,866 tons of copper ore, the larger part of which was smelted in the district and the smaller part, or that produced from the Cleopatra, was treated at the Swansea smelter in Yuma County. A larger smelting plant is about completed in the Verde Valley, at Clarkdale, where the United Verde ores will hereafter be smelted.

Walker district.—The principal producer was the Eureka property, from which ore was produced and milled at Poland, producing bullion and concentrates, which, with the crude ore shipped directly, formed the principal part of the district output aggregating 596 tons of ore.

Walnut Grove district.—A small tonnage of oxidized copper ore was shipped from the McMahon group.

Weaver district.—The placer and deep mine output amounted to $7,506, against a production of $4,839 in 1912. The placer production amounted to $5,515. The dry placers are usually worked by Mexicans with dry washers. During the rainy season rockers are used.

White Picacho district.—The Producer and Gold Rope claims yielded principally gold-silver sulphide ore, with a trace of copper.

YUMA COUNTY.

The output of ore in Yuma County was 23,157 tons in 1913, from 43 producers. This is 11,847 tons more than was produced by 41 operators in 1912. The total average value per ton decreased from $11.27 to $8.25 and the gold and silver value in this ore from $3.09 to $2.51. The total value of the output was $200,786, of which $47,300 in gold was recovered from deep mines and $9,714 in gold from placer surface mines. There was also produced 17,911 ounces of silver, valued at $10,818; 765,501 pounds of copper, valued at $118,653; and 325,020 pounds of lead, valued at $14,301. The total value of the deep-mine output amounted to $191,019. The bulk of the ore, aggregating 11,340 tons, was shipped directly to the smelter at Swansea until it closed in March and to Needles, Humboldt, and El Paso smelters. The total value of the ores shipped to smelters, including a small quantity of lead ore containing gold and silver, amounted to $145,895, or an average value per ton of $12.87. There were treated at gold and silver mills 724 tons of siliceous ore, yielding $26,636 in gold and 2,633 ounces of silver. The placers, chiefly in the Quartzsite region, produced $9,714 in gold and 88 ounces of silver.

Castle Dome district.—Ore from the Castle Dome and Lady Edith mines, which were the principal producers of lead in 1913, consisted principally of galena containing silver. On the Castle Dome property is installed a Stebbins dry concentrating plant operated by gasoline power. The mine is opened by a vertical shaft 185 feet deep and has 800 feet of drifts. The ore output of the district aggregated 1,930 tons, which, with the bullion produced from 3 placers, produced metals valued at $24,319. Gold and silver cyanide precipitates were produced in the 2-stamp mill of the Big Eye property, which worked intermittently during the entire year.

Cienega district.—All of the ore mined was shipped directly to smelters and aggregated 237 tons, containing 112.76 ounces of gold, 56 ounces of silver, and 31,549 pounds of copper. The Copper Queen claim was one of the principal producers.

Ellsworth district.—Nine producers supplied 10,875 tons of ore and tailings, which yielded $26,230 in gold, 1,422 ounces of silver, and 92,277 pounds of copper, valued in all at $41,392. Copper sulphide ore was shipped from the Cunningham Pass properties and the Emerald. The D. & D. produced copper oxidizd ore. Old tailings were re-treated by cyanidation from the Bonanza and Golden Eagle property.

Fortuna district.—The reopening and reequipment of the La Fortuna property has given new life to the district, and a small production was made in 1913. This property is opened by a 2-compartment incline shaft 1,000 feet deep and is equipped with a 20-stamp amalgamation mill.

Kofa district.—A small production of gold bullion was credited to the district by small operators. In 1913 the total output amounted to $2,274, produced from the operations of placers and deep mines.

Mohawk district.—The Red Cross property yielded a small tonnage of sulphide lead ore and siliceous silver ore.

Planet district.—The output of the district, partly estimated, aggregated 8,643 tons of ore and 754 tons of tailings containing 343.80 ounces of gold, 4,134 ounces of silver, and 585,305 pounds of copper. The Swansea mine and smelter, which were closed early in the year, produced the largest part of the output.

Plomosa district.—The output of 10 deep-mine producers and 4 operators and buyers of placer gold amounted to $19,352. The ore production aggregated 641 tons. The larger part, or 436 tons, was shipped directly to the smelters, yielding 309.05 ounces of gold, 297 ounces of silver, and 55,342 pounds of copper. At gold and silver mills 205 tons of ore were treated, yielding 20.96 ounces of gold, 29 ounces of silver, and 6 tons of lead concentrate. The Dutchman property was a producer of copper ore and a siliceous gold ore, and the Desert property produced milling ore, which was treated in the 10-stamp amalgamation mill and yielded copper-lead concentrate and bullion.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY ON METAL MINING AND MINERALS IN ARIZONA.

ADAMS, G. I., Gypsum deposits in the United States: Bull. 223, 129 pp., 1904.

BANCROFT, HOWLAND, Reconnaissance of the ore deposits in northern Yuma County, Ariz.: Bull. 451, 130 pp., 1911.

DOUGLAS, JAMES, Jr., The cupola smelting of copper in Arizona: Min. Resources, 1883 and 1884, pp. 397–410, 1885.

DUTTON, C. E., The physical geology of the Grand Canyon district, Arizona: Second Ann. Rept., pp. 47–166, 1882.

EMMONS, S. F., Copper in the red beds of the Colorado Plateau region: Bull. 260, 1905.

HANCE, J. H., Potash in western saline deposits: Bull. 540, pp. 457–469, 1914.

HEIKES, V. C., Dry placers in Arizona: Mineral resources, 1912, pt. 1, pp. 255–260, 1913.

HILL, J. M., Notes on the placer deposits of Greaterville, Ariz.: Bull. 430, pp. 11–22, 1910.

——— Copper deposits of the White Mesa district, Arizona: Bull 540, pp. 159–163, 1914.

——— The Grand Gulch mining region, Mohave County, Ariz.: Bull. 580, pp. 39–58, 1914.

——— The mining districts of the western United States, with a geologic introduction by Waldemar Lindgren: Bull. 507, 1912.

JAGGER, T. A., Jr., and PALACHE, CHARLES, Geol. Atlas, Bradshaw Mountains folio (No. 126), 1905.

LEE, W. T., Geologic reconnaissance of a part of western Arizona, with notes on the igneous rocks of western Arizona, by Albert Johannsen: Bull. 352, 1908.

LINDGREN, WALDEMAR, The copper deposits of the Clifton-Morenci district, Arizona: Prof. Paper 43, 1905.

——— Copper deposits at Clifton, Ariz.: Bull. 213, 1903.

——— Geol. Atlas, Clifton folio (No. 129), 1905.

NOBLE, L. F., The Shinumo quadrangle, Grand Canyon district, Arizona: Bull. 549, 1914.

RANSOME, F. L., Geology and ore deposits of the Bisbee quadrangle, Arizona: Prof. Paper 21, 1904.

——— The Globe copper district, Arizona: Prof. Paper 12, 1904.

——— Copper deposits near Superior, Ariz.: Bull. 540, pp. 139–158, 1914.

——— The Turquoise copper-mining district, Arizona: Bull. 530, pp. 125–134, 1913.

——— Geol. Atlas, Globe folio (No. 111), 1904.

——— Geol. Atlas, Bisbee folio (No. 112), 1904.

——— The geology and ore deposits of the Bisbee quadrangle, Arizona: Prof. Paper 21, 1904.

——— Copper deposits of Bisbee, Ariz.: Bull. 213, 1903.

ROBINSON, H. H., The San Francisco volcanic field, Arizona: Prof. Paper 76, 1913.

SANFORD, SAMUEL, and STONE, R. W., Useful minerals of the United States, Bull. 585, pp. 11–19, 1914.

SCHRADER, F. C., The mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: Bull. 397, 1909.

——— Mineral deposits of the Santa Rita and Patagonia mountains, Arizona: Bull. 582 (in press).

——— Alunite in granite porphyry near Patagonia, Ariz.: Bull. 540, pp. 347–350, 1914.

LEAD.

By C. E. Siebenthal.

INTRODUCTION.

An estimate of the production of refined lead in 1913 was given out in the form of a press bulletin on January 2, 1914. This was based on reports from every smelter, giving the actual production for the first 10 or 11 months of 1913, with estimates for the remainder of the year. The total thus obtained was almost 1 per cent in excess of the final figures of production. The complete figures of production and consumption of primary [1] refined lead and of imports and exports of lead in ore and bullion were given in the advance statement of lead production, which was published April 9, 1914. The present report contains, in addition, tables and curves showing the production, consumption, imports, exports, and prices for a period of years, a comparison of the mine and the smelter production of lead by States, a list of lead smelters, and a summary of metallurgical advance in 1913.

The statistics of production of lead in this country in 1913 have been compiled by the United States Geological Survey from confidential reports by each lead-smelting company in operation during the year. The statistics of the recovery of secondary lead were also collected by the United States Geological Survey. The statistics of domestic consumption are taken in part from the smelter returns and in part from the records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce, and the tables for foreign production and consumption were compiled from the sources indicated.

STATE OF LEAD INDUSTRY IN 1913.

The production of primary lead from domestic ores in 1913 was 436,430 short tons, valued at $38,405,840, based on the average New York price, as compared with 415,395 tons, valued at $37,385,550, based on the average New York price, in 1912, a gain of 21,035 tons, equal to 5.06 per cent, in quantity and of $1,020,290, equal to 2.73 per cent, in value. The production in 1911 was 405,863 tons, valued at $36,527,670, based on the average New York price.

Though lead prices were maintained at a fairly high level for the first 10 months of the year, the total production in the United States

[1] By primary lead is meant lead which has been produced directly from ore. This term is used for purposes of distinction from secondary lead, which is obtained by refining skimmings, drosses, old metals, etc., figures for the production of which are given on a later page. Wherever in this report the word "lead" is used without qualification primary lead is to be understood.

from all sources fell off over 18,000 tons from the total in 1912, which was lower than that in 1911. This decline in output was due to the shutting down of mines and smelters in Mexico on account of the unsettled conditions in that country, for the production of domestic lead was larger than ever before. The lead of foreign origin smelted or refined in the United States in 1913 was less than half of similar lead refined in each of the three preceding years.

The largest gain in domestic smelter production was made by Utah, with 10,405 tons, or 17 per cent, and Idaho came next with an increase of 10,022 tons, though not so large in proportion. Colorado and California followed with gains of 5,801 and 2,483 tons, respectively. Missouri's output suffered the greatest loss, 10,180 tons, or 6 per cent, notwithstanding which the State retained first place in production, being credited by the smelters with 35 per cent of the total lead production of all the States. For the last three years Idaho has gained annually about 10,000 tons, and Missouri has lost 30,000 tons in the last two years. In one more year, at this rate, Idaho will seriously threaten Missouri's rank for the chief lead-producing State. The lead recovered in the form of pigments from Missouri ores should of course be added to that State's production in reckoning its total smelter production of lead. The general gain by Western States and the losses in output sustained by the Mississippi Valley States increase the production of refined argentiferous lead, compared to nonargentiferous lead, as pointed out in the section on "soft lead."

As has been true for several years, certain important producers were unwilling to report stocks of lead on hand at the close of the year, so that it is not possible to state accurately the deliveries to consumption. As the next best thing, the lead available for consumption is calculated from the domestic production, together with imports, exports, and stocks of foreign lead in bonded warehouse.

PRODUCTION.

PRODUCTION, 1825–1913.

The production of lead in the United States since 1825 from domestic ores and from foreign ores and base bullion is shown in the table following. For the early years, in the absence of official records, the figures have been compiled from the best available sources. The figures for the period from 1825 to 1853 are those published by Whitney; those for the later years were collected by E. A. Caswell. Totals for 1882 were compiled from statistics gathered by the Census Bureau. Since 1882 the figures have been annually collected by the United States Geological Survey.

According to Hahn,[1] argentiferous-lead ore was smelted in Montana and Nevada as early as 1866–67, but for the silver only, as the value of the lead would not pay transportation charges to market. With the completion of the Union Pacific Railroad in 1869 and the development of the mines at Eureka, Nev., the production of lead bullion began. The first figures of this production which are available are for 1873. It is evident from the totals for 1871 and 1872 that not much bullion was produced before 1873. Estimates have

[1] U. S. Geol. Survey Mineral Resources, 1882, p. 324, 1883.

been made for these years, as well as for 1874, in order to arrive at totals for the different classes of lead. Foreign bullion, principally from Mexico, began in 1891 to be imported into this country for refining, but before 1906 the annual quantities so imported were not distinguished in the statistical record of general imports from the lead imported in ore. Since the soft lead is all domestic, the desilverized lead of domestic origin can be readily found by subtracting the total lead of foreign origin from the total desilverized-lead production of that year, or by subtracting the soft lead from the total domestic lead of that year. Prior to 1906 the total production of antimonial lead was included in the production of refined, desilverized lead, but since that date it has been excluded.

Production of refined lead in the United States, 1825–1913, in short tons.

Year.	Antimonial lead.[a]	Desilverized lead.[b]	Soft lead.[c]	Total production.[b]	From domestic ores and base bullion.[b]	From foreign ores.[d]	From foreign base bullion.[e]
1825–1868	.....	.....	676,200	676,200	676,200	.....	.....
1869	.....	.....	17,500	17,500	17,500	.....	.....
1870	.....	.....	17,830	17,830	17,830	.....	.....
1871	.....	[f]1,000	[f]19,000	20,000	20,000	.....	.....
1872	.....	[f]5,380	[f]20,500	25,880	25,880	.....	.....
1873	.....	20,159	22,381	42,540	42,540	.....	.....
1874	.....	[f]28,524	[f]23,556	52,080	52,080	.....	.....
1875	.....	34,909	24,731	59,640	59,640	.....	.....
1876	.....	37,649	26,421	64,070	64,070	.....	.....
1877	.....	50,748	31,152	81,900	81,900	.....	.....
1878	.....	64,290	26,770	91,060	91,060	.....	.....
1879	.....	64,650	28,130	92,780	92,780	.....	.....
1880	.....	70,135	27,690	97,825	97,825	.....	.....
1881	.....	86,315	30,770	117,085	117,085	.....	.....
1882	.....	103,875	29,015	132,890	132,890	.....	.....
1883	.....	122,157	21,800	143,957	143,957	.....	.....
1884	.....	119,965	19,932	139,897	139,897	.....	.....
1885	.....	107,437	21,975	129,412	129,412	.....	.....
1886	.....	114,829	20,800	135,629	130,629	5,000	.....
1887	.....	135,552	25,148	160,700	145,700	15,000	.....
1888	.....	151,465	29,090	180,555	151,919	28,636	.....
1889	.....	153,709	29,258	182,967	156,397	26,570	.....
1890	.....	130,403	31,351	161,754	143,630	18,124	.....
1891	[a]4,043	171,909	31,397	202,406	178,554	23,852	.....
1892	[a]5,039	181,584	31,678	213,262	173,305	39,957	.....
1893	[a]5,013	196,820	32,513	229,333	163,982	65,351	.....
1894	.....	181,404	37,686	219,090	159,351	59,739	.....
1895	.....	201,992	39,890	241,882	165,709	76,173	.....
1896	[a]7,507	221,457	43,537	264,994	187,256	77,738	.....
1897	[a]8,867	247,483	43,553	291,036	207,365	83,671	.....
1898	[a]8,473	267,842	42,779	310,621	210,676	99,945	.....
1899	[a]6,345	263,826	40,566	304,392	208,466	95,926	.....
1900	[a]9,906	329,658	48,021	377,679	270,824	106,855	.....
1901	[a]10,656	323,790	57,898	381,688	269,266	112,422	.....
1902	[a]9,169	303,011	74,050	377,061	276,455	100,606	.....
1903	[a]9,579	295,074	83,444	378,518	290,194	88,324	.....
1904	[a]11,001	315,284	89,169	404,453	308,603	95,850	.....
1905	[a]10,995	313,847	85,455	399,302	318,509	80,793	.....
1906	10,546	313,886	90,860	404,746	336,200	28,803	39,743
1907	9,910	313,588	99,801	413,389	352,381	24,041	36,967
1908	13,629	295,552	101,012	396,564	311,666	11,509	73,389
1909	12,896	329,751	117,158	446,901	352,839	21,754	72,316
1910	14,069	328,954	141,318	470,272	375,402	18,065	76,805
1911	14,078	331,032	155,947	486,979	391,995	10,764	84,220
1912	13,552	339,646	141,248	480,894	392,517	11,572	76,805
1913	16,665	330,593	131,867	462,460	411,878	13,223	37,359
Total	.....	8,000,234	2,981,847	10,982,073	9,044,214	1,937,867	

[a] Included also under desilverized lead and total production prior to 1906.
[b] Including also antimonial lead, except for 1906–1913, inclusive.
[c] Desilverized soft lead is excluded.
[d] Including also lead from foreign base bullion for 1891–1905, inclusive.
[e] Included in lead from foreign ore prior to 1906.
[f] Estimated.

PRODUCTION BY STATES.

The following table showing the production of lead by States is taken, with the exceptions indicated, from two sources which in themselves involve somewhat different methods of compilation. The figures for years prior to 1894 are from the trade statistics of E. A. Caswell and are in terms of refined lead. Compiled from reports by smelters and transportation companies, they probably represent to a certain extent the locality where smelted rather than that of the origin of the ore, but for the period involved these two items must have nearly coincided. For the years 1894 to 1905, inclusive, the figures have been collected by the United States Geological Survey. They were compiled from smelter reports and it should be noted that they represent the content of the ores and not the actual recovery, which is the quantity available for consumption. The latter quantity, termed "merchant lead," may be estimated from the figures of lead content by deducting therefrom a proper allowance for losses in smelting, desilverizing, and refining.

Production of lead by States, 1873–1905, in short tons.

Year.	Argentiferous lead.										Mississippi Valley soft lead.		
	Colorado.	Utah.	Montana.	Idaho.	California.	Arizona.	New Mexico.	Washington.	Nevada.	Other Western States.	Missouri-Kansas.	Southeast Missouri.	Wisconsin-Illinois.
1873	56										15,045		7,336
1874	312												5,400
1875	818										19,099		5,600
1876	667										19,225		7,196
1877	897	24,194	2,912		3,918				19,724	(a)	15,422	9,312	6,418
1878	5,824	21,627	456		4,320				31,063	(a)	11,761	10,517	4,492
1879	22,783	14,370	2,431		2,251				22,805	(a)	14,182	11,158	2,800
1880	34,240	15,214	1,922		2,100				16,659	(a)	15,780	7,970	3,940
1881	42,516	23,973	3,360		3,340				12,826	(a)		30,770	
1882	60,988	29,947							8,590	3,700		29,015	
1883	70,800	33,330							5,775	15,840		21,600	
1884	72,600	30,432	7,470							14,718		18,140	
1885	53,500	29,160	10,993							20,600		21,265	
1886	48,480	24,332	12,632							19,500		22,460	
1887	55,722	22,900	16,000							22,400		27,958	
1888	56,916	22,283	31,400							15,201		31,252	
1889	54,288	31,180	28,400							13,709		27,400	
1890	51,450	34,132	18,300							10,664		33,840	
1891	58,950	43,360	28,000							20,168		29,763	
1892	48,400	45,553	32,600							21,527		32,895	
1893	46,800	35,043	20,045							24,900		32,859	
1894	50,613	23,190	9,637	33,308	478	1,480	2,973		2,254	150		46,300	
1895	46,984	31,305	9,802	31,638	949	2,053	3,040		2,583	381		53,596	
1896	44,803	35,578	11,070	46,662	691	1,165	3,461		1,173	1,006		51,887	
1897	40,576	40,537	12,930	58,627	383	2,184	9,123		959	638		56,542	
1898	57,352	39,299	10,745	59,142	482	2,224	5,797		4,714	1,349		54,469	
1899	70,308	29,987	10,227	52,154	487	3,377	4,856		3,388	862		54,444	
1900	82,137	48,044		85,444	520								
1901	73,265	49,870	5,791	79,654	381	4,045	1,124		1,873	1,029		67,172	
1902	51,833	53,914	4,438	84,742	175	599	741	1,457	1,269	2,184		79,445	
1903	45,554	51,129	3,303	99,590	55	1,493	613	538	2,237	1,765		86,597	
1904	51,884	56,470	3,635	108,854	163	1,499	1,363	622	1,873	41		92,275	
1905	56,638	44,996	2,207	99,027	116	2,091	1,232	56	2,206	101		104,058	

a Included under Montana.

The closer distribution of the lead production among the States from which the ore was derived, which was begun in 1906, has necessitated the separate table which follows. The product of refined lead can with difficulty be apportioned according to sources of ore, owing

to the fact that lead refiners treat smelted products whose origin may, as in custom refining, be unknown to them, the identity of the ore and thus its original source being preserved only so far as the smelter. Accordingly, this table, showing sources of lead smelted or refined in the United States, is based as far as possible on smelter figures. It includes "pig lead" reported by all known smelters running on Mississippi Valley or southern lead ores, and "lead" produced at all other lead smelters in this country. The greater part of the product reported by smelters operated in conjunction with refineries is in terms of refined lead. A like part of the antimonial lead product is thus eliminated from the "lead" produced and appears only in the figures of production of antimonial lead. No lead ore from the United States was treated elsewhere during the period covered by the table.

Sources of primary lead smelted or refined in the United States, 1906–1913, in short tons.

Source of ore.	1906	1907	1908	1909	1910	1911	1912	1913
Domestic ore:								
Alaska	8	.....	3	69	75	51	45	6
Arizona	2,884	2,418	1,464	1,507	948	3,428	3,891	4,901
Arkansas	.....	15	.....	14	.....	15	.....	.....
California	432	938	515	977	1,207	615	811	3,294
Colorado	50,497	52,552	28,729	30,865	38,542	30,442	37,039	42,840
Idaho	117,117	123,292	98,464	103,747	109,951	117,335	127,780	137,802
Illinois	572	498	362	273	263	308	513	619
Iowa	270	225	110	15	.....	.....	.....	.....
Kansas	1,932	1,798	2,293	2,763	1,308	2,522	1,937	1,504
Kentucky	44	75	.....	.....	50	.....	91	16
Missouri	111,075	122,856	122,451	141,105	161,659	182,203	162,610	152,430
Montana	2,485	2,145	2,320	1,451	1,943	2,484	2,517	3,256
Nevada	1,669	3,480	3,796	4,792	2,246	1,082	5,699	6,142
New Mexico	640	2,047	586	1,350	1,890	1,371	2,511	1,821
North Carolina	.....	.....	.....	.....	2	35	34	10
Oklahoma	.....	404	1,409	2,268	1,805	1,925	2,500	3,214
Oregon	.....	5	7	7	.....	11	21	37
South Dakota	.....	.....	13	.....	8	33	12	7
Tennessee	11	16	.....	.....	.....	.....	.....	.....
Texas	25	12	42	44	36	57	30	108
Utah	56,260	55,540	42,455	66,648	60,605	54,933	60,664	71,069
Virginia	.....	83	13	.....	87	400	85	878
Washington	46	341	391	120	339	612	53	9
Wisconsin	1,753	3,573	4,013	3,252	3,909	3,966	3,301	2,639
Undistributed	380	896	36	317	101	48	120	63
Zinc residues	2,053	1,890	1,290	1,735	2,237	1,987	3,131	3,765
Total from domestic ore	350,153	375,099	310,762	363,319	389,211	405,863	415,395	436,430
Foreign ore:								
Africa	.....	288	.....	3,150	3,310	582	1,774	5,976
Canada	7,238	2,607	162	66	25	122	29	16
Central America	112	23	12	20	3	28	.....	.....
Mexico	21,435	20,204	10,145	16,944	11,704	7,333	7,407	4,512
South America	.....	919	1,186	1,536	2,996	2,677	2,332	2,617
Other foreign	18	.....	4	38	27	22	30	102
Foreign base bullion:								
Canada	.....	2,716	179	1,500	.....	.....	.....	.....
Mexico	39,743	34,251	73,210	70,816	76,805	84,220	76,805	37,359
Total from foreign ore and base bullion	68,546	61,008	84,898	94,070	94,870	94,984	88,377	50,582
Grand total, derived from all sources	418,699	436,107	395,660	457,389	484,081	500,847	503,772	487,012

SOFT LEAD.

The lead ores of the Mississippi Valley are almost free from silver, and the lead produced from them is known as "soft lead." A little lead ore derived from Washington and other Western States is also

of this character. All but one of the smelters running exclusively on these soft-lead ores do not desilverize their product. Their output is shown in the "soft-lead" column of the general table of refined lead production for 1825–1913, which is given on a preceding page. However, considerable quantities of the soft-lead ores have been annually smelted by the silver-lead smelters, and, in addition, since 1904 one of the Mississippi Valley smelters has regularly desilverized its product. This desilverized soft lead, for the years prior to 1906, has not been kept separate from the lead produced from silver-lead ores, though the lead content of the soft-lead ores so smelted has been recorded since 1894. Since 1906 the quantity of soft lead produced by each State has been recorded, as shown in the tables below. In the table immediately following, the output of the soft-lead smelters is given in the first column, and the lead content of soft-lead ores smelted and desilverized is given in the second column. For the years 1904 and 1905 a portion of the quantity given in the second column represents lead content of ore, and a portion is refined lead. From 1906 to the present the only quantity given is that of refined lead.

In order to give a fair notion of the annual quantity of refined pig lead recovered from soft-lead ores, the lead recovered from such ores by the silver-lead smelters has been estimated at the rate of recovery used in the official reports for those years. Even so, the figures do not give the total quantity of lead recovered from soft-lead ores. To give the total recovered soft lead there must be taken into account the lead recovered in the form of pigments, as these are made rom soft-lead ores. On this basis the soft lead recovered in 1913 constituted 40 per cent of the total domestic refined lead production plus domestic lead in pigments as compared with 44 per cent in 1912 and with 49.5 per cent in 1911.

Production of soft lead in the United States, 1894–1913, in short tons.

Year.	Undesilverized.	Desilverized.		Total soft lead.
		Lead contents of ore.	Recovered lead.	
1894	37,686	[a] 8,614	[b] 8,097	[b] 45,783
1895	39,890	[a] 13,706	[b] 12,884	[b] 52,774
1896	43,537	[a] 8,350	[b] 7,849	[b] 51,386
1897	43,553	[a] 12,989	[b] 12,210	[b] 55,763
1898	42,779	[a] 11,688	[b] 10,987	[b] 53,766
1899	40,566	[a] 13,878	[b] 13,045	[b] 53,611
1900	48,021	[a] 11,500	[b] 10,810	[b] 58,831
1901	57,898	[a] 9,274	[b] 8,718	[b] 66,616
1902	74,050	[a] 5,395	[b] 5,071	[b] 79,121
1903	83,444	[a] 3,153	[b] 2,961	[b] 86,408
1904	89,169	[c] 5,320	[b] 5,165	[b] 94,334
1905	85,455	[c] 18,603	[b] 18,556	[b] 104,011
1906	90,860	.....	25,000	115,860
1907	99,801	.....	29,829	129,630
1908	101,012	.....	29,869	130,881
1909	117,158	.....	32,532	149,690
1910	141,318	.....	27,952	169,270
1911	155,947	.....	35,667	191,614
1912	141,248	.....	29,789	171,037
1913	131,867	.....	29,433	161,300

[a] Lead content of ores smelted and desilverized.
[b] Estimated recovery of lead from lead content of ore.
[c] In part lead content of ores, in part refined lead.

The table below shows the production of soft pig lead, by States, for the period 1906–1913, which is as far back as the records of the individual production of the Mississippi Valley States are available. The figures include both plain and desilverized soft lead, but do not include the lead content of pigments.

Production of soft pig lead in the United States in 1906–1913, by States, in short tons.

Source of ore.	1906	1907	1908	1909	1910	1911	1912	1913
Arkansas	.....	15	.....	14	.....	15	.....	.....
Illinois	572	498	362	273	263	308	513	619
Iowa	270	225	110	15	.....	.....	.....	.....
Kansas	1,932	1,798	2,293	2,763	1,308	2,522	1,937	1,504
Kentucky	44	75	.....	.....	50	.....	91	16
Missouri	111,075	122,856	122,451	141,105	161,659	182,203	162,610	152,430
Oklahoma	.....	404	1,409	2,268	1,805	1,925	2,500	3,214
Tennessee	11	16	.....	.....	.....	.....	.....	.....
Virginia	.....	83	13	.....	87	400	85	878
Washington	19	87	230	.....	189	275	.....	.....
Wisconsin	1,753	3,573	4,013	3,252	3,909	3,966	3,301	2,639
Undistributed	184	.....	.....	.....	.....	.....	.....	.....
Total	115,860	129,630	130,881	149,690	169,270	191,614	171,037	161,300

ANTIMONIAL LEAD.

The production of antimonial lead from ores derived from all sources, as reported by all desilverizers operating in this country, is shown in the following table:

Production of antimonial lead in the United States from 1891 to 1913, in short tons.

1891	4,043	1903	9,579
1892	5,039	1904	11,001
1893	5,013	1905	10,995
1894	.....	1906	10,546
1895	.....	1907	9,910
1896	7,507	1908	13,629
1897	8,867	1909	12,896
1898	8,473	1910	14,069
1899	6,345	1911	14,078
1900	9,906	1912	13,552
1901	10,656	1913	16,665
1902	9,169		

Production of antimonial lead in the United States, 1907–1913, in short tons.

Year.	From domestic ore.	From foreign ore.	Total.	Value.	Antimony content.	Lead content, by difference.
1907	.....	.....	9,910	$1,322,985	1,561	8,349
1908	.....	.....	13,629	1,264,771	2,440	11,189
1909	8,889	4,007	12,896	1,231,019	2,360	10,536
1910	10,140	3,929	14,069	1,338,090	2,229	11,840
1911	9,636	4,442	14,078	1,380,556	2,254	11,824
1912	8,549	5,003	13,552	1,311,348	1,949	11,603
1913	14,667	1,998	16,665	1,591,854	2,508	14,157
Average composition, by percentage	.....	.....	.....	.....	16.1	83.9

For further details of the production and consumption of antimony in the United States, the reader is referred to the chapter on antimony in this volume.

LEAD PIGMENTS.

In addition to the leaded zinc oxide and zinc-lead oxide pigments, which are noted more particularly in connection with the production of zinc pigments, there are two lead pigments which are produced directly from ore, namely, sublimed white lead and sublimed blue lead. Sublimed white lead consists of lead sulphate 75 per cent, lead oxide 20 per cent, and zinc oxide 5 per cent. Sublimed blue lead consists of lead sulphate 50 to 53 per cent, lead oxide 41 to 38 per cent, with small proportions of lead sulphide, lead sulphite, and zinc oxide. Zinc-lead oxide contains from 46 to 50 per cent of lead sulphate, from 52 to 46 per cent of zinc oxide, and a small quantity of zinc sulphate. Leaded zinc oxide may vary from 4 to 20 per cent in lead sulphate, the remainder being zinc oxide, with a small portion of zinc sulphate.

The total lead content of the production in 1913 from domestic ores of the above-mentioned pigments was 10,998 short tons, as compared with 10,323 tons in 1912, 7,678 tons in 1911, and 7,603 tons in 1910.

SECONDARY LEAD.

Important sources of lead are skimmings, drosses, old metal, and alloys, as babbitt, solder, and type metal. The recovery of lead by refining these materials constitutes an integral portion of the lead industry. This business is mostly carried on at small refineries scattered over the United States, but the large smelters and refineries working primary lead frequently find it advantageous to incorporate material from secondary sources. In such cases it has been noted on the reports of the smelters to the Survey, and to that extent the production of secondary lead has always been taken into account. Since 1907, however, statistics have been collected from the secondary refineries, for the first two years by the writer, and for the last five years by J. P. Dunlop, of the United States Geological Survey. In 1907 and 1908 reports were obtained from the larger plants only, but in 1909 the scope of the canvass was greatly enlarged and the number of firms reporting was increased from 44 to over 100, with the result that the figures of production for later years show a great increase. The product of such secondary refineries is of two classes—pig lead and lead in alloys. In the latter case the lead may have been recovered in the form of pig lead and alloyed at the refinery, or it may have been refined as an alloy, being brought to the desired composition by addition of the requisite metal.

Production of secondary lead in the United States, 1907–1913, in short tons.

	1907	1908	1909	1910	1911	1912	1913
Pig lead	10,153	7,858	18,360	29,492	27,389	30,266	33,104
Lead in alloys	15,508	10,543	23,327	25,930	26,895	36,902	39,730
Total recovered lead	25,661	18,401	41,687	55,422	54,284	67,168	72,834

COMPARISON OF STATE TOTALS BASED ON SMELTER RETURNS AND ON MINE REPORTS.

The foregoing figures of the production of metallic lead by the respective States are compiled from reports of individual lead smelters and refineries. For several years the production of the more valuable metals in the Western States has been obtained by the Survey from reports of individual mines. In 1906 the same method was followed in the Eastern States, and in 1907 the plan was extended to take in the whole country. In order to put the smelter production on the same basis as the mine figures, all the lead which was produced as pigments directly from ore is added to the production of metallic lead. The lead recovered from secondary sources is excluded from these totals, since it has already been reckoned once as pig lead. These facts must be borne in mind in comparing this table with the preceding tables. The State totals obtained by each method for the last six years are compared in the following table:

Comparison of State totals compiled from smelter and mine returns, 1908–1913, in short tons.

State.	1908				1909			
	Totals based on smelter reports.	Totals based on mine reports.	Differences.		Totals based on smelter reports.	Totals based on mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Alaska	3	.....	3	.....	69	19	50	.....
Arizona	1,464	1,504	.....	40	1,507	1,549	.....	42
Arkansas	.....	15	.....	15	14	24	.....	10
California	515	619	.....	104	977	751	226	.....
Colorado	30,853	26,100	4,753	.....	32,451	36,084	.....	3,633
Idaho	98,464	103,414	.....	4,950	103,747	107,993	.....	4,246
Illinois	362	399	.....	37	273	295	.....	22
Iowa	110	51	59	.....	15	36	.....	21
Kansas	2,825	2,518	307	.....	3,084	1,300	1,784	.....
Kentucky	.....	.....	.....	.....	.....	10	.....	10
Missouri	127,620	144,459	.....	16,839	145,827	159,435	.....	13,608
Montana	2,320	2,298	22	.....	1,451	1,492	.....	41
Nevada	3,796	3,623	173	.....	4,792	4,920	.....	128
New Mexico	586	437	149	.....	1,350	2,515	.....	1,165
Oklahoma	1,576	1,781	.....	205	2,820	3,427	.....	607
Oregon	7	1	6	.....	7	.....	7	.....
South Dakota	13	12	1	.....	.....	59	.....	59
Texas	42	33	9	.....	44	46	.....	2
Utah	42,455	44,389	.....	1,934	66,648	74,243	.....	7,595
Virginia	13	38	.....	25	.....	.....	.....	.....
Washington	593	575	18	.....	120	144	.....	24
Wisconsin	4,097	4,138	.....	41	3,363	3,694	.....	331
Undistributed	36	.....	36	.....	317	.....	317	.....
Zinc residues	1,290	.....	1,290	.....	1,735	.....	1,735	.....
Total	319,040	336,404	.....	.....	370,611	398,036	.....	.....

Comparison of State totals compiled from smelter and mine returns, 1908–1913, in short tons—Continued.

State.	1910				1911			
	Totals based on smelter reports.	Totals based on mine reports.	Differences.		Totals based on smelter reports.	Totals based on mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Alaska	75	28	47	.....	51	24	27	.....
Arizona	948	1,348	.....	400	3,428	5,137	.....	1,709
Arkansas	.....	63	.....	63	21	64	.....	43
California	1,207	1,435	.....	228	615	699	.....	84
Colorado	39,864	38,036	1,828	.....	31,718	34,840	.....	3,122
Idaho	109,951	114,129	.....	4,178	117,335	136,278	.....	18,943
Illinois	263	373	.....	110	308	964	.....	656
Iowa	.....	20	.....	20	.....	60	.....	60
Kansas	1,581	2,412	.....	831	2,775	2,859	.....	84
Kentucky	50	41	9	.....	.....	.....	.....	.....
Missouri	166,298	161,016	5,282	.....	187,384	178,868	8,516	.....
Montana	1,943	2,053	.....	110	2,484	3,216	.....	732
Nevada	2,246	2,436	.....	190	1,082	1,632	.....	550
New Mexico	1,890	2,160	.....	270	1,371	1,483	.....	112
North Carolina	2	.....	2	.....	35	.....	35	.....
Oklahoma	2,612	2,888	.....	276	2,553	2,501	52	.....
Oregon	.....	.....	.....	.....	11	.....	11	.....
South Dakota	8	7	1	.....	33	32	1	.....
Texas	36	33	3	.....	57	61	.....	4
Utah	60,605	61,662	.....	1,057	55,070	68,248	.....	13,178
Virginia	87	99	.....	12	400	417	.....	17
Washington	339	661	.....	322	612	424	188	.....
Wisconsin	4,152	4,413	.....	261	4,163	3,353	810	.....
Undistributed	101	.....	101	.....	48	.....	48	.....
Zinc residues	2,237	.....	2,237	.....	1,987	.....	1,987	.....
Total	396,495	395,313	.....	.....	413,541	441,160	.....	.....

State.	1912				1913			
	Totals based on smelter reports.	Totals based on mine reports.	Differences.		Totals based on smelter reports.	Totals based on mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Alaska	45	.....	45	.....	6	18	.....	12
Arizona	3,891	3,403	488	.....	4,901	8,072	.....	3,171
Arkansas	.....	31	.....	31	.....	18	.....	18
California	811	572	239	.....	3,294	1,757	1,537	.....
Colorado	39,348	37,621	727	.....	44,708	43,949	759	.....
Idaho	127,780	142,093	.....	14,313	137,802	158,936	.....	21,134
Illinois	513	1,282	.....	769	625	959	.....	334
Iowa	.....	63	.....	63	.....	65	.....	65
Kansas	2,187	2,371	.....	184	1,650	2,427	.....	777
Kentucky	91	106	.....	15	16	22	.....	6
Missouri	168,483	177,069	.....	8,586	160,326	176,116	.....	15,790
Montana	2,518	3,723	.....	1,205	3,256	5,468	.....	2,212
Nevada	5,707	9,750	.....	4,043	6,152	8,172	.....	2,020
New Mexico	2,511	2,747	.....	236	1,821	1,973	.....	152
North Carolina	34	46	.....	12	10	.....	10	.....
Oklahoma	3,056	3,388	.....	332	3,895	6,228	.....	2,333
Oregon	21	20	1	.....	37	44	.....	7
South Dakota	12	11	1	.....	7	5	2	.....
Texas	30	33	.....	3	108	113	.....	5
Utah	60,913	70,156	.....	9,243	71,283	83,063	.....	11,780
Virginia	85	235	.....	150	951	816	135	.....
Washington	53	64	.....	11	9	101	.....	92
Wisconsin	3,326	2,581	745	.....	2,743	1,866	877	.....
Undistributed	120	.....	120	.....	63	.....	63	.....
Zinc residues	3,131	.....	3,131	.....	3,765	.....	3,765	.....
Total	424,666	457,365	.....	.....	447,428	500,188	.....	.....

The smelter totals represent actual recovery and are found by summing up the total production reported by all companies for each State, respectively, and recalculating all pigments back to equivalent metallic lead on the basis of average analysis of product. In compiling the mine totals each producing property is requested to report actual tonnage of lead ores and concentrates shipped, and from this tonnage the lead content is reckoned by assay value. The quantities thus obtained from all the producing properties in each State are combined to make the total for that State. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from every producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content be correctly estimated.

With equal conditions affecting the mines and the smelters, the stocks in the ore bins of the smelters should run about even from year to year, and the mine and smelter State totals, making allowance in the former for losses in smelting, should show reasonable agreement. As may be seen from the table, however, there are frequent discrepancies. The causes of these descrepancies fall into four categories. The first is lag, by which is meant the time that elapses between the shipment of ore by the mine and the reduction of the ore by the smelter. This is frequently considerable, for ore raised near the end of the year may remain in the stock bins of the smelter until the succeeding year, and, unless balanced by an equivalent lag from the preceeding year, will thus lead to an apparent "mine excess." Near the close of 1911 there were reports in the mining journals of the accumulation of 30,000 tons of lead ore at the Tooele smelter then under construction, but which did not blow in until 1912. The lead content of this ore appears as "mine excess" in the 1911 reports for the Western States furnishing the ore, notably Utah and Idaho. If through accident, business depression, or otherwise, the mines close down, the smelters largely consume their ore stocks, which results in an apparent "smelter excess." The second source of difference is found in error in the mine totals, either in ore tonnage or in the arbitrary calculation of metal content from assay. The dry assay in vogue in the Western States gives results uniformly too low. A decision of the United States circuit court (T. D. 21653) recognizes a differential of 1.5 per cent between the dry assay and chemical analysis, and in actual practice the discrepancy is probably even greater than that figure. A third source is found in failure of the smelter returns to segregate accurately the ore from the different States. Until 1906 the ore coming from the Joplin district was lumped by the smelters as from Missouri or Missouri-Kansas, though some of it was from Oklahoma. This tended to make a smelter excess for Missouri and a mine excess for Kansas and Oklahoma. The same custom was to a certain extent true of the upper Mississippi Valley district. Though apportioned to the proper States since 1906, the division is confessedly a rough estimate in the case of some of the smelters which do not keep the ore from these regions separate on their books. Lastly, there is not taken into account in these totals, except in certain of the Western States, the loss in smelting, ranging from 2 to 5 per cent in treating easily reducible ores and up to 10 or more per cent in the more refractory ores. Losses run-

ning over 20 per cent have been claimed in smelting ores running high in antimony and arsenic. Lag being left out of account, each State would normally show a mine excess equal to this smelting loss. Any discrepancy which appears in the table may reasonably be ascribed to one or more of these items. In the long run, barring error and allowing for smelting losses and exportation of ore, the "mine excess" will be balanced by equivalent "smelter excess."

SMELTER AND MINE STATE TOTALS IN 1913.

As no allowance for smelting losses has been made in the mine totals, except as noted, only those mine excesses which are notably above the normal loss in smelting need be discussed here.

The mine excess in Arizona seems to be partly due to lag in smelting, as is usual when States are rapidly increasing in mine output as Arizona did in 1913. But it may also be due in part to wrong distribution by the smelters, since it is partly balanced by a smelter excess in California. The custom concentrator at Needles, Cal., treats a great deal of Arizona ore, and this fact is probably responsible for some of the error. The large mine excess in Idaho is largely due to lag in smelting. Mine excesses in Missouri, Kansas, and Oklahoma are apparently due to lag in smelting. Mine excesses in Montana, Nevada, and Utah, in the main accompanying increased mine production, seem to be due to lag in smelting. The smelter excess in Wisconsin, associated with decreased mine production, indicates depletion of Wisconsin lead ore stocks at smelters.

RESOURCES.

MINE PRODUCTION OF LEAD IN UNITED STATES IN 1913.

The following table shows for each lead-producing State the total quantity of lead-bearing ores produced and the output of each kind of lead-bearing ore. The column headed "All other ores" includes copper ore, copper-lead ore, and dry or siliceous ore. "Dry" ores produced in Colorado contained 12,521 short tons of lead. This, as in other States, was concentrated from parts of the ore from certain counties, however, and was not distributed through the whole of the "All other ore" credited to Colorado. The total crude ore yielding either gold, silver, copper, lead, or zinc is given for each lead-producing State, so that a comparison may be made of the relative extent of deep-mining operations in these States, the quantity of crude ore raised being the best measure for this purpose. As shown by the table, Missouri takes the same dominating position in the production of crude lead ore and lead-bearing zinc ores that was noted in the discussion of the table showing source of zinc mined in the United States in 1913, as given in the chapter on zinc in Mineral Resources. Missouri produced nearly two-thirds of the crude lead ore and over two-thirds of the crude lead-bearing zinc ore mined in the United States in 1913 and occupied the first rank in output of crude ore carrying any or all of the five metals named above.

The table also gives the quantity of lead contained in the crude ores of each State in 1913 and the lead content of each kind of lead-bearing ore. The percentage of lead contained in the lead ore, the lead-zinc ore, and the zinc ore of each State is also given. The lead

content of lead ore, in States having a considerable production, ranged from 16.9 per cent in New Mexico down to 3.5 per cent in Missouri, the average for all the States being 5.6 per cent. The lead-zinc ores were somewhat less rich in lead than the lead ores, averaging 4 per cent. The average lead content of the zinc ores was 0.4 per cent, this low figure being due to the preponderance of low-grade lead-bearing zinc ores in the Central States. Of the total mine production of lead in 1913, a quantity corresponding to 76.8 per cent was derived from lead ores, 11.4 per cent was derived from lead-zinc ores, 8.2 per cent was derived from zinc ores, and 3.6 per cent was recovered from all other ores. The figures of mine production of lead are taken from the chapters on gold, silver, copper, lead, and zinc in the various States, as indicated in the prefatory note.

63057°—M R 1913—VOL 1——46

Source of lead mined in the United States in 1913, by States and kinds of ore, in short tons.

State.	Lead ores.			Lead-zinc ores.			Zinc ores.			All other ores.		Total.	
	Crude ore.	Lead content.	Percentage.	Crude ore.	Lead content.	Percentage.	Crude ore.	Lead content.	Percentage.	Crude ore.	Lead content.	Crude ore.	Lead content.
Alaska										1,750,262	18	1,750,262	18
Arizona	28,551	4,805	16.8	29,700	2,406	8.1	14,554	68	0.5	7,859,057	793	7,931,862	8,072
Arkansas							13,000	18	.1			13,000	18
California	14,267	1,757	12.3				1,823			2,479,868		2,495,958	1,757
Colorado	205,774	19,699	9.6	203,367	11,659	5.7	141,295	70	.0	2,184,430	12,521	2,734,866	43,949
Idaho	1,598,344	133,843	8.4	646,080	25,086	3.9	2,978	3	.1	204,190	4	2,451,592	158,936
Illinois							119,200	588	.5	(a)	371	a 119,200	959
Iowa	650	65	10.0									650	65
Kansas							590,300	2,427	.4			590,300	2,427
Kentucky										(a)	22	(a)	22
Missouri	4,250,800	147,558	3.5				8,049,300	28,558	.4			12,300,100	176,116
Montana	27,270	2,840	10.4	307,615	2,386	.8	3,840			5,621,393	242	5,960,118	5,468
Nevada	18,976	2,639	13.9	16,749	2,518	13.9	10,208	44	.4	5,321,278	2,971	5,367,211	8,172
New Mexico	7,762	1,312	16.9	8,735	593	6.8	40,439			2,160,724	68	2,217,660	1,973
Oklahoma							581,100	6,228	1.1			581,100	6,228
Oregon	75	14	18.7							155,826	30	155,901	44
South Dakota	28	5	17.9							1,899,139		1,899,167	5
Texas	12	3	25.0	3,172	90	2.8				21,890	20	25,074	113
Utah	662,200	69,038	10.4	211,609	12,501	5.9	16,322	436	2.7	9,312,435	1,088	10,202,566	83,063
Virginia							30,034	816	2.7	882		30,916	816
Washington	645	101	15.7							115,040		115,685	101
Wisconsin							1,406,000	1,866	.1			1,406,000	1,866
Total	6,815,354	383,679	5.6	1,427,027	57,239	4.0	11,020,392	41,122	.4	39,086,414	18,148	58,349,188	500,188
Percentage of total lead derived from each kind of ore.	76.8			11.4			8.2			3.6		100.0	

a Tonnage of fluorspar from which lead was recovered as a by-product is not taken into account.

REVIEW BY DISTRICTS.

For details of production in the several lead-producing districts of the United States the reader is referred to the mines reports for the individual States appearing elsewhere in Mineral Resources for 1913. This review is based on those reports or on notes furnished by the authors of the various mines reports. Only the general trend of development during the year will be here considered in connection with the different districts.

EASTERN STATES.

In the Eastern States numerous veins of lead have been prospected and worked spasmodically, though in but three or four States have these operations developed into the caliber of lead mines.

In New York lead ore has been mined in quantity in the northern part of the State, in the Rossie district, and in the southern part of the State, near Ellenville, Wurtzboro, and Guymard. In 1911–12 a vein of lead ore near Gouverneur was prospected and a small shipment of sorted ore was made to the smelter. This resulted in the recovery of a small quantity of lead and a nominal quantity of gold and silver.

The Virginia lead ores have been known and mined for more than 150 years, the mines at Austinville being the oldest workings. Lead ore, associated with zinc, occurs at the Pulaski, Austinville, Cedar Valley, and Albemarle mines. The production of lead by Virginia mines in 1913 was 816 short tons, about three and one-half times as great as the output in 1912. This came chiefly from the deeper workings of the Austinville mine, but some also came from old tailings remilled in Wythe County. Prospects showing lead as well as zinc were developed at the Allah Cooper property, near Mineral, Louisa County, and at the Holliday property, which lies on an extension of the same belt; also near Timberville, Rockingham County.

In North Carolina lead ores have been mined in the Silver Hill district, Davidson County. The Washington mine, yielding argentiferous sulphides of zinc, lead, copper, and iron, was worked in 1836–1852 and some years thereafter to a depth of 650 feet. Other mines were worked later at Silver Valley and a smelter was erected at Thomasville, but there was no production from the State for about 25 years until the last three years, when zinc-lead sulphide ores from the Silver Hill district yielded 46 tons of lead in 1912 and smaller quantities in the two preceding years. No lead ore was produced in 1913.

The lead ores of Tennessee are subordinate to the zinc ores, with which they generally occur. The New Prospect mine, in the Lead Mine Bend of Powell River, in Union County, has yielded both lead and zinc ores, but has not been worked for many years. The Blue Springs mine, 6 miles south of Cleveland, was operated for many years as a lead mine, though not lately. In the recently discovered zinc deposits at the old iron mines at Embreeville there are scattering masses of galena ore. These have been hand picked and stored, but no shipments have been made.

CENTRAL STATES.

The upper Mississippi Valley region, embracing adjoining portions of Wisconsin, Illinois, and Iowa, was the scene of some of the earliest lead mining in the United States. The mines were at first worked exclusively for lead, but since 1860 the production of zinc ore has predominated over that of lead ore, with which the zinc ore is associated in many mines. The lead content of lead concentrates produced in the district in 1913 was 2,519 tons, a loss of 812 tons, or nearly one-fourth from 1912. The prevailing low price of lead ore was mainly responsible.

The Kentucky-Illinois fluorspar region yields some lead ore, mostly obtained as concentrates in the reduction of crude fluorspar. The production of lead from this source has been unimportant in the last few years, owing to the depression in the fluorspar industry. The enlargement of fluorspar-concentrating plants in southern Illinois in 1911, together with the prosperous condition of the fluorspar industry in 1911–12, led to an increase in the output of lead concentrates from that region. In 1913, however, owing partly to the low price of lead and partly to high water in Ohio River, which flooded the large mines and mills and put them out of commission for a considerable period, the output of lead was but little more than half of that of 1912. Not all the ore mined during the year was sold.

The southeastern Missouri disseminated lead district varied only a few hundred tons from the lead output of 1912, making a slight gain both in concentrates and in lead content. This was accomplished in spite of labor troubles which entailed the shutting down of the mines and pumps for 10 days during August, during which time several of the mines were flooded and time was necessarily lost in pumping them out. The St. Joseph Lead Co. and the Doe Run Lead Co. were merged under the name of the former company. The St. Louis Smelting & Refining Co. leased for 10 years the old Mine La Motte property and also received the crude ore from the Potosi Lead Co.'s mine for treatment. The Federal Lead Co. operated the Catherine mine. There was considerable activity in prospecting during the year, and drill strikes of disseminated lead ore at a depth of 800 to 900 feet were reported from the vicinity of Potosi.

The Joplin region includes southwestern Missouri, southeastern Kansas, and northeastern Oklahoma. This is the greatest zinc-producing area in the United States, and furnished 30 per cent of the total recoverable zinc production of 1913. The lead is practically all recovered as a by-product in concentrating the zinc ores. The lead content of the lead concentrates produced in the Joplin region in 1913 was 37,213 tons, an increase of about 4 per cent over the output of 1912. The lead output of Kansas was just about the same as in 1912, but southwestern Missouri fell off about 1,600 tons, which was more than made up by the increased output of the mines at Miami, Okla.

Northern Arkansas had a very small output of lead concentrates made in concentrating zinc ores.

WESTERN STATES.

Texas increased the lead output from 33 tons in 1912 to 113 tons in 1913. This product largely came from the Bonanza mine, in the Sierra Blanca district of El Paso County.

The lead output of New Mexico fell off 774 tons, or 28 per cent, being 1,973 tons, as compared with 2,747 tons in 1912. The zinc-producing districts of New Mexico also yielded the lead output of the State, which came chiefly from the Magdalena district of Socorro County.

Colorado's lead production showed a good gain, being 43,949 tons, as compared with 37,621 tons in 1912, a difference of 6,328 tons, or 17 per cent. Lake County, containing the Leadville district, produced one-third of the State total, the next counties in order of output being Pitkin, San Juan, San Miguel, Clear Creek, and Summit.

The lead production of Montana was 5,468 tons, an increase of 1,745 tons, nearly 50 per cent more than in 1912. This increase was mostly due to lead concentrates from the zinc-lead ores of the Butte district of Silver Bow County. The remainder of the lead came from Cascade and Jefferson counties.

The lead output of Idaho made another important gain, being 158,936 tons, as against 142,093 tons in 1912, an increase of 16,843 tons, or 12 per cent. This was the largest output of lead ever made by the State. Shoshone County, containing the Cœur d'Alene district, produced 93 per cent of the total, and about 3 per cent came from Lemhi and 3 per cent from Fremont counties.

Utah made a good gain in lead production, with 83,063 tons, compared to 70,156 tons in 1912, an increase of 12,907 tons, or over 18 per cent. The Bingham district was the largest producer. This gain was largely due to the increased output of low-grade ore in the Bingham district, which gained nearly one-half in output and furnished 42.7 per cent of the State's total lead. The Park City district and the Tintic district were next in order of output.

Arizona lead made a splendid gain, more than doubling the output in 1912, by producing 8,072 tons in 1913, as compared with 3,403 tons the preceding year, an increase of 4,669 tons. Cochise County, from the Warren district, produced nearly half of the total lead; Mohave County was the next largest producer, with Pima and Santa Cruz counties following.

The lead production of Nevada fell off over 16 per cent in 1913, being 8,172 tons, as compared with 9,750 tons in 1912. Lincoln and Clark counties were the largest producers. The decrease in output was due largely to the lessened shipments from the Bullionville tailing dump, near Pioche, Lincoln County.

California trebled her lead output with 1,757 tons, as compared to 572 tons the previous year. This gain was chiefly a result of the resumption of operations at the Tecopa mine, in Inyo County.

There was a small production of lead in Oregon, from six different counties, a total of 44 tons, as compared with 20 tons in 1912.

Washington produced 101 tons of lead in 1913, as compared with 64 tons in 1912, mostly from the Bossburg district of Stevens County.

METALLURGY.

CONCENTRATION AND SEPARATION.

The problems of concentration and separation of lead ores do not differ essentially from those concerning zinc ores or the complex sulphide ores of lead and zinc. The various adaptations of the principles of flotation and of electrostatic separation to such ores have been discussed in the chapters on zinc in Mineral Resources of the United States for 1908 and for 1910–1913, to which the reader is referred.

SMELTING.

LEAD SMELTERS AND REFINERIES IN 1913.

In the following list the attempt has been made to give all the lead smelters and refineries in existence or under construction in North America in 1913. The plants which produced in 1913 are given in ordinary type; those which were idle are listed in italic.

Lead smelters and refineries in North America in 1913.

UNITED STATES.

Arizona:
- Mowry—*Consolidated Mines, Smelter & Transportation Co.*[1]

California:
- Keeler—*Four Metals Mining & Smelting Co.*[1]
- Needles—Needles Mining & Smelting Co.[2]
- Selby—Selby Smelting & Lead Co.[3] Refinery also.

Colorado:
- Denver—Globe plant, American Smelting & Refining Co.
- Durango—Durango plant, American Smelting & Refining Co.
- Leadville—Arkansas Valley plant, American Smelting & Refining Co.
- Pueblo—Pueblo plant, American Smelting & Refining Co.
- Salida—The Ohio & Colorado Smelting & Refining Co.

Idaho:
- Clayton—Red Bird Smelting Co.
- Enaville—*North Fork Smelting & Mining Co.*
- Ponderay—*Idaho Smelting & Refining Co.*[1]
- Sea Foam—*Greyhound Mining & Milling Co.*
- Wardner—Bunker Hill & Sullivan Co. (Malm dry chlorination process.) Under construction.

Illinois:
- Aurora—Aurora Metal Co.[4]
- Chicago—Goldsmith Bros.' Smelting & Refining Co.[4]
- Chicago—Great Western Smelting & Refining Co.[4]
- Chicago—National plant, American Smelting & Refining Co. Refinery only.
- Collinsville—St. Louis Smelting & Refining Co.[5] Refinery also.
- Federal—Federal Lead Co.[3]
- Granite City—Hoyt Metal Co.[4]

Indiana:
- East Chicago—International Lead Refining Co.[6] Refinery only
- East Chicago—U. S. Reduction Co.[4]
- Grasselli—United States Metals Refining Co.[2] Refinery only. Betts electrolytic process.

Iowa:
- Dubuque—*J. W. Watters.*[1]

---

[1] Not operated for several years.
[2] Subsidiary of United States Smelting, Refining & Mining Co.
[3] Subsidiary of American Smelters Securities Co.
[4] Smelters of secondary materials, but treating some lead ores.
[5] Subsidiary of National Lead Co.
[6] Subsidiary of International Smelting & Refining Co.

Kansas:
Galena—Galena Smelting & Manufacturing Co.
Missouri:
Desloge—Desloge Consolidated Lead Co.
Granby—Granby Mining & Smelting Co.
Herculaneum—St. Joseph Lead Co.
Joplin—Picher Lead Co.
Valle Mines—*Valle Mining Co.*[1]
Webb City—Webb City Smelting & Manufacturing Co.
Montana:
Cooke—*New World Smelter & Mining Co.*
East Helena—East Helena plant, American Smelting & Refining Co.
Nebraska:
Omaha—Omaha & Grant Smelting Co.[2] Refinery only. Betts electrolytic process.
Nevada:
Nelson—*Santa Barbara Searchlight Mining Co.*[1]
Spruce—*Black Forest Mines & Smelting Co.*[1]
New Jersey:
Newark—Balbach Smelting & Refining Co. Refinery also.
Perth Amboy—Perth Amboy plant, American Smelting & Refining Co. Refinery also.
New Mexico:
Deming—*National Mining & Smelting Co.*[1]
Pennsylvania:
Carnegie—Pennsylvania Smelting Co. Refinery also.
Texas:
El Paso—Kansas City Consolidated Smelting & Refining Co.[2]
Utah:
Midvale—United States Smelting Co.[3]
Murray—Murray plant, American Smelting & Refining Co.
Silver City—*Tintic Smelting Co.*[1]
International—International Smelting Co.
Washington:
Keller—*Keller & Indiana Consolidated Smelting Co.*[1]
Wisconsin:
Dodgeville—*Blue Mounds Mining & Smelting Co.*[1]
Waukesha—*Northern Smelting Co.*[1]

CANADA.

British Columbia:
Trail—Consolidated Mining & Smelting Co. of Canada (Ltd.). Refinery also. Betts electrolytic process.
Ontario:
Kingston—North American Smelting Co. (Ltd.).

MEXICO.

Aguascalientes:
Aguascalientes.—American Smelting & Refining Co.
Chihuahua:
Chihuahua.—American Smelting & Refining Co.
Uruachic.—Uruáchic Mining & Smelting Co. (Ltd.).
Coahuila:
Saltillo.—Mazapil Copper Co. (Ltd.).
Torreon.—Compañía Metalúrgica de Torreón.
Durango:
Asarco (Velardena).—American Smelters Securities Co.
Mapimi.—Compañía Minera de Penoles.[5]
Guerrero:
Campo Morado.—*Reforma Mining & Milling Co.*[1]

[1] Not operated for several years.
[2] Subsidiary of American Smelting & Refining Co.
[3] Subsidiary of United States Smelting, Refining & Mining Co.
[4] Subsidiary of American Smelters Securities Co.
[5] Subsidiary of American Metal Co.

Nuevo Leon:
Monterey.—American Smelting & Refining Co.
Monterey.—Compañía Minera, Fundidora y Afinidora, S. A.[1] Refinery also.
San Luis Potosi:
Matehuala.—American Smelters Securities Co. (National Metallurgical Co.)
San Luis Potosi.—Compañía Metalúrgica Mexicana.
Sonora:
Guaymas.—*Pacific Smelting & Refining Co.*[2,3] (*Mexican-American Smelting & Refining Co. (Ltd.).*
Ures.— *Yaqui Smelting & Refining Co., S. A.*[2,4] *Refinery also.*
Zacatecas:
Chalchihuites.—*National Smelting Co.*[2]

TRADE CONDITIONS.

WORLD'S PRODUCTION.

The following table of the production of lead in the world has been calculated from the statistics published by the Metallgesellschaft, of Frankfurt-am-Main, Germany, with the exception of the substitution of the figures collected by the United States Geological Suryey for the production of the United States. It is to be noted that the production of Africa and South America is not separately given in the table. As shown on a preceding page, considerable lead has been smelted and refined in the United States in the last seven years from ores produced in those countries:

The world's production of lead, 1906–1913, in short tons.

Country.	1906	1907	1908	1909	1910	1911	1912	1913
Australia	102,514	106,923	131,174	85,098	108,907	109,789	118,387	127,867
Austria-Hungary	18,078	16,975	16,094	15,432	19,290	21,605	23,589	26,565
Belgium	24,471	28,417	39,352	44,423	44,864	48,832	56,438	55,997
Canada	26,235	13,338	18,849	22,928	16,535	11,795	17,968	18,849
France	28,219	25,353	28,770	29,652	22,266	26,014	34,282	30,864
Germany	166,117	157,156	185,076	184,745	174,604	181,218	194,666	199,627
Great Britain	26,455	30,203	32,738	31,085	32,628	28,660	32,187	33,620
Greece	13,338	15,212	17,637	16,865	18,519	15,763	15,983	20,282
Italy	23,479	25,243	28,660	24,361	15,983	18,408	23,699	23,920
Japan	3,858	3,858	3,197	3,748	3,858	4,630	4,960	3,968
Mexico	59,524	79,366	121,253	130,071	133,048	137,347	132,276	68,343
Russia	331	110	110	882	1,323	1,102	1,102	1,102
Spain	199,406	204,918	202,052	202,823	211,531	193,013	205,799	223,767
Sweden	882	882	331	220	441	1,213	1,433	1,653
Turkey in Asia	10,582	11,464	13,007	13,338	13,999	13,668	13,779	15,322
Other countries	220	220	551	6,393	17,306	22,597	13,448	6,834
United States (domestic, refined)	336,200	352,381	311,666	352,839	375,402	391,995	392,517	411,878
Total	1,039,909	1,072,019	1,150,517	1,164,903	1,210,504	1,227,648	1,282,513	1,270,458
United States percentage of world's production	32.3	32.9	27.1	30.3	31.0	32.0	30.6	32.4

A decrease of 12,055 short tons, or 9 per cent, was shown in the world's production of lead in 1913. This was a result of the war in Mexico, the output of which country fell off 63,933 tons, or nearly 50 per cent. France and Austria-Hungary also showed losses of about 10 per cent. The United States made the largest gain, with an increase of 19,361 tons, or nearly 5 per cent. The United States output was 32.4 per cent of the world's production. Spain had the next largest gain, with 17,968 tons increase, or 9 per cent. Australia gained 8 per cent, or 9,480 tons, and other gains were made by Germany, Greece, Turkey, and Japan.

[1] Plant destroyed during Mexican civil war, 1914.
[2] Not operated for several years.
[3] Built several years ago; never blown in.
[4] Plans to blow in shortly.

THE LEAD INDUSTRY AS AFFECTED BY THE WAR IN EUROPE.

The following notes on the lead industry of the United States in its relation to the markets of the world, particularly as affected by the present war in Europe, were published in United States Geological Survey Bulletin 599, and are incorporated here for the sake of the general interest of the subject.

General conditions.—The effect of the war in Europe upon the lead situation is uncertain. One month of war has not disturbed the already low price of lead in the United States. It would seem that the conflict must ultimately enhance the value of the metal. All exports from that country of lead as well as of copper and zinc, have been forbidden by the British Government, which has requisitioned all visible supplies, so that there is no lead now available for the consumer. Great Britain will apparently be the best market at present for American lead, although the lead now imported into England comes mostly from Spain and Australia, and will naturally continue to come from those countries so long as ocean transportation is available. In 1913 the imports of lead into Great Britain exceeded her exports of lead by over 180,000 short tons.

Production in principal countries.—As already appears in the preceding table, the production of refined lead output in the principal producing countries in 1912 and 1913 was as follows:

Production of lead in principal producing countries in 1912 and 1913, in short tons.

Country.	1912	1913
United States (domestic refined)	392,517	411,878
Spain	205,799	223,767
Germany	194,666	199,627
Australia	118,387	127,867
Mexico	132,276	68,343
Belgium	56,438	55,997
Great Britain	32,187	33,620
France	34,282	30,864
Other countries	115,961	118,495
Total	1,282,513	1,270,458

It seems likely that the war may curtail this output by 250,000 tons, about one-fifth of the total production. Inasmuch as the product of those countries affected by the war would probably have been mostly consumed in the countries themselves, and as they are not now in a position to use much of the metal in arts and manufactures, it seems probable that the market value of the lead will not be much affected by the curtailment of production.

Foreign lead smelted in the United States and exported.—Lead smelted from foreign ore in bond, and articles manufactured from foreign lead and exported with benefit of drawback, have been exported in large quantities for many years as shown by the following table, which shows also the production of lead in the United States from domestic and from foreign ores.

Production and export of lead in United States, 1909–1914, in short tons.

Year.	Production.		Exports.	
	From domestic ore.	From foreign ore and bullion.	From warehouse.	Under drawback.
1909	352,839	97,040	86,077	4,796
1910	375,402	94,870	69,786	8,800
1911	391,995	94,984	101,227	12,080
1912	392,517	88,377	64,906	11,320
1913	411,878	50,582	44,544	9,757
1914			[a] 8,833	

[a] Six months only.

There has been a rapid and progressive decline in the quantity of foreign lead smelted in the United States since 1911, due to the unsettled conditions in Mexico. There has been a similar decline in foreign exports. For the current year the exports

of bonded lead will apparently not be more than one-third of what they were in 1913, and about one-seventh of what they were four years ago. The stock of foreign lead of all kinds remaining in warehouse June 30, 1914, was 7,237 short tons, principally at New York and at El Paso.

Exports of domestic lead.—For many years prior to 1914 there have been no exports of domestic lead ore, bullion, or pig lead. Manufactures only of domestic lead have been exported. During the first seven months of 1914, the London price of lead averaged 4.136 cents a pound, as against 3.962 cents, the price at New York. The difference in March, June, and July was about three-tenths of a cent a pound. By August 19 the London price had increased to 4.875 cents a pound, a full cent a pound above the New York price. Since March there have been important exports of domestic lead to Europe, as follows:

Exports of domestic lead in 1914 in short tons.

March	5,838
April	5,931
May	2,045
June	6,348
July	10,219+
Total	30,381+

The production of domestic lead in 1913 was the largest in the history of the industry, and trade conditions during that year make it probable that there was considerable increase in domestic stocks. The exports of domestic lead, however, must have gone far toward relieving this condition. A continuation of these exportations must result in advanced prices in the United States.

Destination of domestic lead exported, March–June, 1914, in short tons.

Great Britain	7,153
Germany	5,141
Netherlands	4,720
Belgium	2,101
Russia	448
Other countries	599
Total	20,162

The exports up to and including June, 1914, were principally to continental Europe, a little going to Russia, as indicated in the table above: but with the differential, between London and New York prices which obtained in the middle of August, lead will no doubt be exported to London.

IMPORTS AND EXPORTS.

WAREHOUSE TRANSACTIONS.

Lead imported into the United States as metal or in ore may be entered for immediate consumption, in which case the duty is paid and the lead goes direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. From warehouse the lead may be withdrawn for consumption by payment of duty, or it may remain in bond for smelting and refining, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The lead entered for immediate consumption and that withdrawn from warehouse for consumption make up the table below of imports for consumption which are expressed in the same terms as those in which they were imported. The lead imported for consumption may be actually used in this country, or it may be manufactured into articles which are exported, in which case the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table below, showing foreign lead exported in manufactures with benefit of drawback, the lead is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the

articles exported with benefit of drawback. The foreign lead given in the table below as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse.

The two items, foreign lead exported from warehouse and foreign lead exported in manufactures with benefit of drawback, make up the total foreign lead going out of the country. Lead in warehouse and deductions by liquidation being disregarded, the difference between the sum of these two exports of lead and the total imports of lead constitutes the foreign lead consumed in this country. For the sake of simplicity this foreign lead is carried on the bonded customs warehouse records in the form in which the lead was entered until the bond is canceled. It must be clearly understood, therefore, that in the table of foreign exports of lead, on a later page, the lead there listed was not exported as lead content of ore and base bullion but as refined lead smelted and refined from them. There is no record kept of the lead in the form in which it is actually exported except for a portion of the articles manufactured from foreign lead and exported with benefit of drawback. For articles not made wholly of lead it would be useless to give weights. But each shipment on which drawback is claimed is accompanied by a manifest of the imported lead used in making the articles and the duty paid thereon. From these manifests is derived the statement of the total quantity of foreign lead used in manufactures exported with the benefit of drawback. For this reason the lead is given in the form in which it was imported.

The following table, taken from the reports of the Bureau of Foreign and Domestic Commerce, shows the lead remaining in warehouse at the close of each year, beginning with 1899, and also the district in which remaining. For the reasons given above, the lead is shown in the terms in which imported. For instance, a considerable part of the lead stated as remaining in ore and base bullion doubtless represents refined lead waiting at the bonded refinery for a favorable market for shipment. If this be borne in mind, the table gives a fair idea of the fluctuations of foreign stock at different times and in different localities.

Lead remaining in warehouse, 1899–1913, in pounds.

Dec. 31—	Form in which entered for warehouse.		Remaining at [a]—					
			New York.		Chicago, Ill.	El Paso, Tex.	San Francisco, Cal.	Puget Sound.
	Lead in ore and base bullion.	Pigs, bars, and old.	Newark, N. J.	Perth Amboy, N. J.				
1899	22,302,286	17,033	6,343,323	12,070,835	215,032	2,552,911	122,851	976,012
1900	42,379,270	.....	10,692,307	10,157,018	2,236,555	2,642,568	3,149,975	6,147,500
1901	33,225,677	18,808	5,927,039	7,964,931	.....	1,325,874	2,521,095	6,122,420
1902	47,817,806	59,487	8,193,289	14,176,762	4,157,558	2,949,481	3,745,809	2,073,152
1903	21,387,901	.....	5,192,823	3,850,638	3,896,471	4,079,021	3,430,526	933,422
1904	22,962,984	.....	1,629,852	7,482,560	5,999,972	6,062,072	1,732,742	46,295
1905	16,296,391	112	10,117	6,746,035	3,755,890	4,553,951	260,777	941,623
1906	11,382,998	128,812	1,743,853	3,870,951	2,736,979	229,267	306,607	2,480,817
1907	25,794,409	93,286	1,057,836	6,197,503	7,918,991	8,846,533	1,226,261	.....
1908	36,923,604	206,651	6,772,049	23,356,695	3,950,517	2,381,867	15,526	.....
1909	34,655,780	158,208	4,941,828	18,213,808	9,461,123	1,832,867	39,911	.....
1910	71,794,443	149,082	7,548,936	36,112,136	21,090,631	6,937,667	.....	.....
1911	8,869,713	93,082	2,777,692	2,308,322	954,884	2,555,733	.....	.....
1912	20,891,182	93,802	1,880,828	17,666,768	484,671	767,533	.....	.....
1913	10,620,953	.....	8,785,551		80,880	1,683,091	.....	.....

[a] Also in 1900 at Kansas City, Mo., 1,776,137 pounds, and at Omaha, Nebr., 5,306,351 pounds; in 1901 at Denver, Colo., 9,364,318 pounds; in 1902, at Denver, Colo., 12,516,815 pounds; in 1911 at Kansas City, Mo., 273,082 pounds; in 1912 at Kansas City, Mo., 91,382 pounds; and in 1913 at St. Louis, Mo., 71,431 pounds.

IMPORTS.

The following tables of lead and type metal imported and entered for consumption and of general imports of lead are taken from the reports and records of the Bureau of Foreign and Domestic Commerce:

Lead imported and entered for consumption in the United States, 1900–1913, in pounds.

Year.	Lead in ore.[a]		Base bullion.[b]		Pigs, bars, and old.		Sheets, pipe, and shot.		Not otherwise specified.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1900	10,209,742	$623,802			3,673,616	$76,141	27,945	$1,393	$877	$702,213
1901	10,324,119	272,396			3,604,157	88,056	56,735	2,773	1,234	364,459
1902	14,499,339	316,005			12,443,615	319,035	224,209	7,765	5,258	648,063
1903	41,155,130	716,128			8,972,635	255,135	17,008	810	1,589	973,662
1904	19,015,540	328,279			17,334,033	480,823	69,581	2,441	5,277	816,820
1905	49,526,990	784,548			10,379,753	329,209	77,668	3,813	1,139	1,118,709
1906	44,560,258	755,545	587,731	$15,635	24,882,983	960,998	346,177	17,250	4,503	1,753,931
1907	13,363,875	286,802	1,196,224	35,303	15,667,170	718,198	734,418	39,210	3,450	1,082,944
1908	2,806,524	76,746	11,415,463	251,266	5,346,290	176,363	42,377	2,026	9,843	516,244
1909	7,080,753	142,847	21,896,611	454,568	7,095,442	229,751	40,434	2,056	32,284	861,506
1910	7,998,859	198,196	16,543,167	337,223	6,776,066	212,858	39,779	1,972	4,843	755,092
1911	1,474,254	26,563	17,376,459	352,595	7,112,749	242,423	63,151	2,855	7,218	631,654
1912	935,861	24,760	22,729,467	462,559	5,191,823	110,459	31,184	2,305	5,468	605,551
1913	2,306,972	75,835	17,665,227	388,116	4,621,270	105,738	39,171	3,291	12,710	572,980

[a] For period 1900–1905, inclusive, the gross weight and value of base bullion imported for consumption are also included.

[b] For the years pervious to 1906 the imports of base bullion (gross weight) are not distinguished from imports of lead in ore.

Type metal imported and entered for consumption, 1899–1913, in pounds.

Year.	Type metal.		Lead content.[a]	
	Gross weight.	Value.	Pounds.	Percentage.
1899	1,110,188	$56,442		
1900	1,032,866	51,242		
1901	3,222,431	116,875		
1902	6,469,971	194,394		
1903	6,603,863	208,728		
1904	8,143,749	221,127	6,884,423	84.5
1905	13,932,013	456,155	11,476,629	82.4
1906	19,602,471	900,608	15,896,629	81.1
1907	14,832,673	932,027	12,095,027	81.5
1908	4,110,486	156,847	3,265,815	79.5
1909	13,993,889	532,108	11,339,378	81.0
1910	13,394,199	485,493	11,176,830	84.9
1911	8,390,470	310,658	6,936,711	82.7
1912	581,411	18,668	477,006	82.0
1913	567,004	20,098	467,688	82.5
Average lead content, 1904–1913				82.0

[a] Prior to 1904 the lead content of the type metal was not given. Besides lead, the chief constituent of the type metal is antimony.

Imports of lead, in ore, base bullion, and refined, by countries, 1907–1913, in pounds.

Country.	1907	1908	1909	1910	1911	1912	1913
United Kingdom	433,971	399,569	191,243	1,874,750	401,686	279,546	404,594
Germany	456,649	695,151	2,821,967	421,377	56,286	494,237	262,132
Other European countries	6,922,276	1,699,509	1,385,616	418,669	111,189	55,356	143,293
Total from Europe	7,812,896	2,794,229	4,398,826	2,714,796	569,161	829,139	810,019
British North America	13,272,900	1,291,044	4,133,755	206,979	270,947	319,497	338,569
Mexico	137,543,692	219,567,193	215,203,714	203,290,307	172,633,479	159,455,664	95,693,439
South America	883,355	469,776	1,942,847	6,598,263	4,778,221	3,207,936	8,766,327
Other countries	117,138	26,418	2,683,950	4,394,421	1,651,544	3,309,356	8,685,612
Total imports	159,629,981	224,148,654	228,363,092	217,204,766	179,903,352	167,121,592	114,293,966

In the foregoing table the lead imports in 1913 from Europe contained 737,725 pounds of lead in ore. Of the lead imported from Mexico, 4,050,093 pounds was in ore, 91,630,731 pounds was contained in the base bullion, constituting the whole imports of base bullion into the United States, and 12,615 pounds was in the form of refined lead. From Chile there was imported 6,073,131 pounds of lead in lead ore and from German East Africa 8,568,587 pounds in lead ore.

The table following shows the imports of lead in ore, base bullion, and pigs, bars, sheets, and old for the years 1907–1913.

Imports of lead, by classes, 1907–1913, in pounds.

Year.	Lead in ore (lead content).	Base bullion.		Pigs, bars, sheets, and old.	Total lead content.[a]
		Gross weight.	Lead content.[a]		
1907	64,815,254	76,259,828	74,594,313	18,554,899	157,964,466
1908	64,708,204	153,921,829	150,560,176	5,518,621	220,787,001
1909	71,357,868	149,852,559	146,579,779	7,152,665	225,090,312
1910	94,751,054	118,061,415	115,483,542	6,970,170	217,204,766
1911	35,686,180	141,481,852	138,952,372	5,264,800	179,903,352
1912	19,577,499	152,420,624	146,999,168	544,925	167,121,592
1913	19,883,313	96,908,170	94,327,654	82,999	114,293,966

[a] Lead content of bullion for 1907–1909 estimated on the basis of average lead content of imports of base bullion in 1910.

EXPORTS.

DOMESTIC EXPORTS.

The average difference between the New York and the London lead prices for the last 10 years has been not far from 1½ cents per pound. This being the case, domestic lead exports should be expected only under temporary and very unusual circumstances. The practice of the Bureau of Foreign and Domestic Commerce is to class all exports of lead articles manufactured in this country as domestic exports, whether the lead be of domestic or foreign origin. The table of exported lead and manufactures of lead of domestic production, made up from the records of the Bureau of Foreign and Domestic Commerce, and heretofore published in this report, must be duplicated in

part, if not completely, in the following table of exports of manufactures with benefit of drawback. For this reason it has been decided to abandon the table of domestic exports as previously published.

FOREIGN EXPORTS.

By foreign lead exports is meant the exports of lead of foreign origin which has been smelted, refined, or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Foreign and Domestic Commerce, shows the total lead exported for a period of years; but it must be borne in mind, as pointed out on a previous page, that the actual exports were not in the form shown in the table, which is the import form, but instead consisted of refined lead and lead manufactures. The quantities of lead exported from warehouse are exact, but the quantities given of lead in manufactures are subject to the waste in manufacturing.

Under the present tariff regulation as also under the tariff of 1909 the lead that must be sent out before the bond can be canceled is that actually recovered in smelting and refining the ore and base bullion. Under the tariff of 1897 the bond was canceled when 90 per cent of the lead content of the ore or gross weight of the base bullion was shipped out. If, then, in refining base bullion more than 90 per cent of the total weight was recovered as lead, the bond would be canceled on the exportation of that 90 per cent and the excess above 90 per cent could remain in this country without payment of duty. No doubt prior to 1909 considerable foreign lead used in this country has escaped duty in this wise.

Exports of foreign lead, 1900–1913, in pounds.

Year.	Exported from warehouse.							Exported in manufactures with benefit of drawback.	
	Lead content ore.[a]		Lead content base bullion.[a]		Pigs, bars, and old.		All other manufactures.	Lead content ore.	Pigs, bars, bullion, and old.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Value.	Quantity.	Quantity.
1900	197,795,960	$3,840,798			30,163	$564	$2,519	1,705,970	6,861,030
1901	194,724,197	4,183,101			50,000	2,500	4,924	9,452,628	5,935,331
1902	157,891,135	3,551,380			43,130	1,000	764	2,173,559	9,501,049
1903	163,774,605	2,908,531			55,566	1,627	7,799	2,339,106	9,331,256
1904	167,686,199	2,844,403			87,471	3,937	32,467	2,946,810	10,445,974
1905	117,263,861	2,378,327			1,647,523	54,993	7,846	3,584,610	12,700,971
1906	94,449,751	2,303,382			48,680	1,138	2,825	3,447,478	8,536,424
1907	102,847,310	2,416,082			47,078	2,169	3,033	1,826,756	14,709,149
1908	153,657,371	3,068,427			56,000	1,500	32,026	9,392,428	9,114,209
1909	118,325,560	2,002,644	[b] 53,817,393	$1,036,080	11,447	487	697	2,992,967	6,598,149
1910	22,508,090	248,220	117,045,333	2,262,057	19,507	703	870	6,592,294	11,008,604
1911	39,276,820	730,247	151,986,265	3,093,290	12,311,102	244,037	1,504	674,621	23,485,929
1912	12,796,703	219,859	116,907,305	2,478,256	107,170	3,826	2,121	150,617	22,584,221
1913	11,721,714	271,985	77,253,891	1,827,538	111,506	4,851	3,422	74,628	19,484,345

[a] Prior to June, 1909, exports of foreign lead from warehouse do not distinguish between lead content of ore and gross weight of base bullion.

[b] For six months, July–December, 1909.

CUSTOMS DUTIES

TARIFF.

The sections of the tariff act of 1909 which were concerned with lead and lead products are as follows:

181. Lead-bearing ore of all kinds, one and one-half cents per pound on the lead contained therein: *Provided*, That on all importations of lead-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

182. Lead dross, lead bullion or base bullion, lead in pigs and bars, lead in any form not specially provided for in this section, old refuse lead run into blocks and bars, and old scrap lead fit only to be remanufactured; all the foregoing, two and one-eighth cents per pound; lead in sheets, pipe, shot, glaziers' lead, and lead wire, two and three-eighths cents per pound.

191. Type metal, one and one-half cents per pound on the lead contained therein.

49. Red lead, two and five-eighths cents per pound.

53. White lead, and white pigment containing lead dry or in pulp, or ground or mixed with oil, two and one-half cents per pound.

58. Lead: Acetate of, white, three cents per pound; brown, gray, or yellow, two cents per pound; nitrate of, two and one-fourth cents per pound; litharge, two and one-half cents per pound.

SEC. 24. That the works of manufacturers engaged in smelting or refining, or both, of ores and crude metals may, upon the giving of satisfactory bonds, be designated as bonded smelting warehouses. Ores or crude metals may be removed from the vessel or other vehicle in which imported, or from a bonded warehouse, into a bonded smelting warehouse without the payment of duties thereon and there smelted or refined, or both, together with other ores or crude metals of home or foreign production: *Provided*, That the several charges against such bonds may be canceled upon the exportation or delivery to a bonded manufacturing warehouse, established under section twenty-three of this act, of the actual amount of lead produced from the smelting or refining, or both, of such ores or crude metals: *And provided further*, That said lead may be withdrawn for domestic consumption or transferred to a bonded customs warehouse and withdrawn therefrom upon the payment of the duties chargeable against it in that condition: *Provided further*, That all labor performed and services rendered pursuant to this section shall be under the supervision of an officer of the customs, to be appointed by the Secretary of the Treasury, and at the expense of the manufacturer: *Provided further*, That all regulations for the carrying out of this section shall be prescribed by the Secretary of the Treasury.

The American Smelting & Refining Co. protested the assessment of a duty of 2⅛ cents per pound upon antimonial lead withdrawn from the bonded smelting warehouse at Perth Amboy. It was claimed that the by-product, antimonial lead, is of the composition of type metal, that it was withdrawn for use as type metal, and that it should be dutiable at the rate of type metal—that is, 1½ cents per pound upon the lead contents thereof, as provided in paragraph 191 of the tariff of 1909. It was also urged that the same results could be secured by withdrawing the antimonial lead from bond for export and thereafter reimporting it as type metal. The United States Board of Appraisers (T. D. 31201) affirmed the assessment of duty and overruled the protest. The importers having appealed the case to the United States

Court of Customs Appeals, that body, October 12, 1911, reversed the decision of the Board of Appraisers. During the course of the appeal it developed that antimonial lead has an average composition of 81 per cent of lead, 17 per cent of antimony, and 2 per cent of other metals, such as arsenic, copper, etc., and that since 1907 it has been regularly imported and entered for consumption as type metal. In this connection it may be remarked that a comparison of the table of production of antimonial lead showing the antimony content of that metal and the table of imports of type metal showing the lead content of that metal is in substantial agreement with the foregoing fact.

In response to a request for instructions from the collector of customs at El Paso regarding the proper classification of matte entered as copper matte, but containing from 4 to 18 per cent of lead, the Treasury Department ruled (T. D. 32439) that matte containing more than 10 per cent of lead is not properly a copper matte, entering duty free, but is dutiable under paragraph 181 of the tariff act of 1909 at 1½ cents per pound on the lead contained.

The tariff act of 1913 has the following paragraphs relating to lead and lead compounds:

152. Lead-bearing ores of all kinds containing more than 3 per centum of lead, ¾ cent per pound on the lead contained therein: *Provided*, That on all importations of lead-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

153. Lead dross, lead bullion or base bullion, lead in pigs and bars, lead in any form not specially provided for in this section, old refuse lead run into blocks and bars, and old scrap lead fit only to be remanufactured; lead in sheets, pipe, shot, glaziers' lead, and lead wire; all the foregoing, 25 per centum ad valorem, on the lead contained therein.

160. Type metal, and types, 15 per centum ad valorem.

56. Lead pigments: Litharge, orange mineral, red lead, white lead, and all pigments containing lead, dry or in pulp, and ground or mixed with oil or water, not specially provided for in this section, 25 per centum ad valorem.

57. Lead, acetate of, white, and nitrate of, 1¼ cents per pound; acetate of, brown, gray, or yellow, 1 cent per pound; all other lead compounds not specially provided for in this section, 20 per centum ad valorem.

The new tariff modifies section 24 of the tariff of 1909 by substituting the word "metal" where the word "lead" is used, so as to make smelting in bond apply to all other metals as well as to lead.

N. Subsection 1. That the works of manufacturers engaged in smelting or refining, or both, of ores and crude metals, may upon the giving of satisfactory bonds be designated as bonded smelting warehouses. Ores or crude metals may be removed from the vessel or other vehicle in which imported, or from a bonded warehouse, into a bonded smelting warehouse without the payment of duties thereon and there smelted or refined, or both, together with ores of crude metals of home or foreign production: *Provided*, That the bonds shall be charged with the amount of duties payable upon such ores and crude metals at the time of their importation, and the several charges against such bonds may be canceled upon the exportation or delivery to a bonded manufacturing warehouse established under Paragraph M of this section of an amount

of the same kind of metal equal to the actual amount of dutiable metal producible from the smelting or refining, or both, of such ores or crude metals as determined from time to time by the Secretary of the Treasury: *And provided further*, That the said metals so producible, or any portion thereof, may be withdrawn for domestic consumption, or transferred to a bonded customs warehouse, and withdrawn therefrom, and the several charges against the bonds canceled upon the payment of the duties chargeable against an equivalent amount of ores or crude metals from which said metal would be producible in their condition as imported: *And provided further*, That on the arrival of the ores and crude metals at such establishments they shall be sampled and assayed according to commercial methods under the supervision of Government officers, to be appointed by the Secretary of the Treasury and at the expense of the manufacturer: *Provided further*, That antimonial lead produced in said establishments may be withdrawn for consumption upon the payment of the duties chargeable against it as type metal under existing law and the charges against the bonds canceled in a similar sum: *Provided further*, That all labor performed and services rendered pursuant to this section shall be under the supervision of an officer of the customs, to be appointed by the Secretary of the Treasury, and at the expense of the manufacturer: *Provided further*, That all regulations for the carrying out of this section shall be prescribed by the Secretary of the Treasury.

June 12, 1914, the Treasury Department ruled as follows (T. D. 34540) regarding the drawback on articles manufactured from lead smelted in bond:

In the matter of the liquidation of drawback entries covering articles manufactured with the use of lead produced in bonded smelting warehouses from imported ore, the question at issue is whether in the liquidation of drawback entries covering articles manufactured in the United States from such lead allowance shall be made for waste in smelting and refining.

Under paragraph N of section 4 of the tariff act of 1913, on the withdrawal for domestic consumption of lead produced in bonded smelting warehouses from imported ores, duty is assessed on an equivalent amount of ore from which the lead would be producible in its condition as imported without any allowance for waste, which invariably occurs. Under section 29 of the tariff act of 1897, on the withdrawal of such lead for domestic consumption, duty was assessed on the lead content of the ore from which it was produced.

While the two statutes cited differ in phraseology, their effect on such lead withdrawn from bonded smelting warehouse for consumption in the United States is the same. The question of the legality and propriety of an allowance for waste in smelting and refining, where such metals are used in the manufacture of other articles in the United States under the act of 1897, was settled in favor of the proposition by T. D. 19670 of July 19, 1898, T. D. 21251 of June 12, 1899, T. D. 24910 of October 21, 1902, and T. D. 25777 of November 18, 1904, all of which decisions must be read in connection with one another.

Under the circumstances, in the liquidation of entries at your port covering articles manufactured from lead produced in bonded smelting warehouse from imported ores, an allowance may be made for waste in smelting and refining equal to the difference in the quantity of lead actually withdrawn and the quantity of which duty was paid.

Under the tariff of 1897 the customs bond was canceled upon the exportation of 90 per cent of the weight of base bullion or lead contents of ore imported. Under the tariff of 1909 the bond is canceled only upon the exportation of the actual quantity of lead produced from the base bullion and ore. This change made it compulsory upon the Treasury Department to ascertain the exact recovery and wastage of lead. Prof. H. O. Hofman, of the Massachusetts Institute of Technology, was employed to investigate the wastage in both smelting and refining at the various bonded smelters. His report, being confidential, has not been given out by the Treasury Department. The following, taken from the Engineering and Mining Journal of June 17, 1911, purports to give the general results of the investigation:

It appears that Prof. Hofman in his investigations at the various bonded smelting warehouses found that there was a wide divergence in the amount of waste at the

various places owing to the different character of the ores. He therefore recommended the establishment of the actual wastage at each plant as determined from a scrutiny of the records for three years back. * * * Prof. Hofman's reports showed that the wastage in smelting varied from 5 or 6 per cent at some plants to over 20 at others. There was also a wide variation of the loss incurred in refining base bullion, the figure running as low as less than 1 per cent in some cases, while in others it was very greatly in excess of that. Probably the most refractory ores studied by Prof. Hofman were those which were smelted at Perth Amboy, N. J. These are the Canadian ores, and the difficulty with them is due to the presence of large quantities of arsenates. Some plants have stopped smelting these ores on account of the high percentage of waste connected with them.

From the same journal, under date of March 8, 1913, the following, relating to a later examination, is taken:

The Treasury Department has completed investigations as to works of the American Smelting & Refining Co. at Perth Amboy, N. J., and finds that there was a loss in the operation equal to 20 per cent to be accounted for as wasted. In lead bullion it was found from the records that there was a loss in refining operations equal to 3.7 per cent to be accounted for as wasted. Previous regulations were modified in conformity to these findings. As a result of recent experience it is now stated that the department will fix wastage allowances each year. Notification has been sent to the companies that they will have to prepare to make detailed statements of the facts, showing the loss on the metals worked during the fiscal year ending June 30 in each year. An allowance of 19.9 per cent in the smelting of imported lead-bearing ores has been granted in the case of El Paso Smelting & Refining Works at El Paso, Tex.

Again from this journal, under date of February 14, 1914, the following results of a third examination are quoted:

According to press dispatches, notices have been sent to various collectors of customs by Assistant Secretary of the Treasury Hamlin, fixing the wastage allowances on lead-bearing ores smelted and refined in bonded warehouses, according to the customs regulations now in effect. For the Balbach Smelting & Refining Co., Newark, N. J., the Treasury permits a smelting loss on imported lead-bearing ores of 6.45 per cent and a refining loss on foreign lead bullion of 2.07 per cent. For the American Smelting & Refining Co. at its Perth Amboy, N. J., plant the smelting loss is fixed at 20 per cent and the refining loss at 2.32 per cent; at its South Chicago, Ill., plant the refining loss is fixed at 1.59 per cent. For the El Paso Smelting Works, El Paso, Tex., the smelting loss of 18.56 per cent is continued.

CONSUMPTION.

In statements of consumption of lead in these reports prior to 1907 it was the custom to take into account the smelter stocks of lead at the beginning and at the close of the year. It is not to be denied that for the individual year this gives closer figures. It is just as true that account of trade stocks should also be taken to arrive at accurate results; but this is manifestly outside the scope of this bureau. It has been found impossible to obtain a statement of stocks from one large producer since 1906; hence consumption has been calculated without reference to domestic stocks. A very considerable part, however, amounting to between one-fourth and one-fifth of the lead smelted and refined in this county, is lead of foreign origin smelted in bond, and it is possible to obtain the stocks of this portion, since they are reported annually by the Bureau of Foreign and Domestic Commerce as "merchandise remaining in warehouse at close of year." A certain element of error is introduced by the fact that the imports, the exports, and the warehouse stocks, as given, include lead in both ore and base bullion. So far as imports are concerned, the relative quantities of lead in ore and of base bullion are shown in the table on a preceding page, entitled "Imports of lead, by classes," based upon the records of the Bureau of Foreign and

Domestic Commerce, and corroborated in the preceding table giving the "sources of primary lead smelted or refined in the United States," based upon smelter reports. For exports and warehouse stocks no such division can be made, because the classes used therein represent the condition of the metal when imported and do not change with the reduction of the metal in bond. Nevertheless, it is deemed advisable to use warehouse stocks as giving a better estimate of consumption. It is necessary, therefore, to include all classes of lead imports as well as all classes of lead exports.

In the following table "lead" includes all kinds—lead in ore, base bullion, pigs, bars, and old. The figures of domestic production are based upon the returns by the smelters; all other figures are from the records of the Bureau of Foreign and Domestic Commerce. Decrease by liquidation covers losses in smelting and refining in bond and other corrections. Because warehouse stocks are used in lieu of smelter stocks the result given below is lead "available for consumption." The "apparent consumption" of previous reports would be this quantity increased or diminished by the increase or decrease of domestic stocks during the year.

Primary lead available for consumption in the United States, 1907–1913, in short tons.

	1907	1908	1909	1910	1911	1912	1913
Supply:							
Stock in bonded warehouses Jan. 1	5,756	12,944	18,565	17,405	35,972	4,481	10,492
Imports							
For consumption	15,246	9,805	18,036	15,359	13,281	14,146	11,980
For warehouse	64,569	102,241	96,145	93,249	76,671	69,414	45,165
Production from domestic ores	352,381	311,666	352,839	375,402	391,995	392,517	411,878
Total supply	437,952	436,656	485,585	501,415	517,919	480,558	479,515
Withdrawn:							
Exports of foreign lead—							
From warehouse	51,447	76,857	86,077	69,786	101,227	64,906	44,544
In manufactures, with benefit of drawback	8,268	9,254	4,796	8,800	12,080	11,320	9,779
Decrease by liquidation	4,578	13,425	8,643	7,661	14,812	5,692	419
Stock in bonded warehouses Dec. 31	12,944	18,565	17,405	35,972	4,481	10,492	5,310
Total withdrawn	77,237	118,101	116,921	122,219	132,600	92,410	60,052
Available for consumption	360,715	318,555	368,664	379,196	385,319	388,148	419,463

For facility of comparison of consumption in the United States with that of the world, the consumption of the former has been calculated with and without stocks for a period of years, as shown in the following table. Consumption of lead, as shown in the second column, means the production of refined lead minus excess of exports over imports or plus excess of imports over exports. Additions made to stock during the year will thus appear as consumed, but as such stocks are apt to go into the market within the next year and cut down the apparent consumption to that extent, they must compensate in the long run, leaving an accurate average measure of the consumption. The statistics of consumption of foreign countries as given in the table are taken from the estimates of the Metallgesellschaft, etc., which are also compiled without regard to stocks. In the following table, the first column gives, for the sake of comparison, the consump-

tion with stocks taken into consideration; the remainder of the table disregards stocks. In neither column showing the United States consumption is the production of secondary lead taken into account.

World's consumption of pig lead, exclusive of secondary lead, 1898–1913, in short tons.

Year.	Stocks considered.	Stocks disregarded.			
	United States.	United States.	Foreign countries.	Total world's consumption.	United States, percentage.
1898	227,452	225,177	651,018	876,195	25.7
1899	226,315	230,294	652,782	883,076	26.1
1900	269,302	279,172	667,002	946,174	29.5
1901	271,934	284,126	663,805	947,931	29.9
1902	332,484	300,643	685,079	985,722	30.5
1903	300,167	284,556	701,945	986,501	28.8
1904	319,543	320,330	719,471	1,039,801	30.8
1905	347,015	343,682	736,998	1,080,680	31.8
1906	376,337	376,981	705,142	1,082,123	34.8
1907	[a] 360,715	367,903	710,102	1,078,005	34.1
1908	[a] 318,555	324,176	833,293	1,157,469	28.0
1909	[a] 368,664	367,504	814,708	1,182,212	31.1
1910	[a] 379,196	397,763	811,292	1,209,055	32.9
1911	[a] 385,319	353,828	865,086	1,218,914	29.0
1912	[a] 388,148	394,159	885,587	1,279,746	30.8
1913	[a] 419,463	414,281	876,218	1,290,499	32.1

[a] See preceding table, "Primary lead available for consumption in the United States" in 1907–1913.

Consumption of lead, stocks and secondary lead disregarded, in 1907–1913, by countries, in short tons.

Country.	1907	1908	1909	1910	1911	1912	1913
Australia	5,952	8,501	5,401	7,937	10,031	11,133	10,582
Austria-Hungary	27,778	31,906	34,171	34,722	39,903	41,667	39,132
Belgium	56,596	28,880	48,060	35,274	47,399	49,493	47,289
Canada	15,073	15,102	23,589	19,621	23,259	33,069	25,243
France	89,397	114,749	112,765	98,986	109,789	115,411	118,607
Germany	206,130	237,215	234,680	230,270	256,726	255,844	246,364
Great Britain	214,287	252,595	223,436	229,719	218,586	216,381	210,980
Holland	5,732	5,961	6,704	7,165	7,496	6,944	10,472
Italy	33,290	40,296	34,612	31,085	40,013	36,376	35,935
Japan	15,983	10,582	12,676	18,188	20,833	24,030	20,393
Russia	27,668	49,349	42,328	53,792	47,289	50,265	64,815
Switzerland	5,842	6,514	5,842	6,504	5,512	7,055	6,393
Other European countries	3,417	4,416	4,409	4,740	3,858	4,850	6,944
Other countries	22,377	27,227	26,235	33,289	34,392	33,069	33,069
United States	367,903	324,176	367,504	397,763	353,828	394,159	414,281
Total	1,078,005	1,157,469	1,182,212	1,209,055	1,218,914	1,279,746	1,290,499

PRICES AND VALUE.

PRICES.

Lead began the year at New York with a price of 4.35 cents a pound and held at practically that figure through the first seven months of the year. A sharp rise beginning late in July carried the price to 4.85 cents a pound in the last week of August, the maximum price of the year. A steady decline then brought the price to 4 cents a pound by the middle of December, the lowest price of the year, and at about this figure the year closed. The average New York price for the year was 4.4 cents a pound, compared with the average of 4.5 cents a

pound in 1912 and in 1911. These are the figures used in calculating the value of the lead production of the United States for those years.

The London price of lead started at £17 17s. 6d. a long ton (3.87 cents a pound) and gradually dropped until on March 10 the minimum for the year was reached at £15 8s. 9d. a long ton (3.33 cents a pound). From this point there was a rapid recovery until June 19, when the high point for the year was reached, lead selling for £21 10s. a long ton (4.65 cents a pound). There was a drop of about half a cent a pound early in July, which was recovered by the close of the month, and from then until the middle of November the price remained practically stationary. During the latter half of November and early in December there was another decline which brought the price down to £17 17s. 6d. a long ton (3.87 cents a pound), and the market closed at about this figure. As may be seen by inspection of the price curves (fig. 1), the London price of lead slightly exceeded the New York price three times during 1913—late in June, early in August, and late in October. The yearly average price of lead at London was £18 15s. 8d. a long ton (4.06 cents a pound).

In the following table are shown the highest and the lowest prices of lead at New York in each month during the last 12 years. All figures for prices are in cents per pound. For years prior to 1907 the figures are based upon quotations published in the Iron Age. From 1907 to 1910, inclusive, the figures are taken from the Engineering and Mining Journal. Since 1910 the quotations of the Steel and Metal Digest have been used.

Highest and lowest prices of lead at New York City, monthly, 1901–1913, in cents per pound.

Year.	January.		February.		March.		April.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½
1902	4.10	4.00	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.10	4.05	4.10	4.05	4.65	4.10	4.65	4.35
1904	4.50	4.45	4.50	4.40	4.60	4.50	4.60	4.50
1905	4.60	4.45	4.50	4.45	4.50	4.45	4.55	4.50
1906	5.60	5.60	5.60	5.35	5.35	5.35	5.50	5.35
1907	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
1908	3.80	3.55	3.75	3.70	4.00	3.65	4.10	3.90
1909	4.22½	4.12½	4.15	3.92½	4.10	3.92½	4.25	4.10
1910	4.70	4.70	4.70	4.52½	4.60	4.35	4.40	4.35
1911	4.52½	4.50	4.50	4.50	4.50	4.45	4.50	4.47½
1912	4.50	4.25	4.30	4.05	4.25	4.05	4.30	4.17½
1913	4.375	4.35	4.40	4.35	4.40	4.35	4.50	4.35

Year.	May.		June.		July.		August.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½
1902	4.10	4.05	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.35	4.30	4.35	4.10	4.10	4.05	4.10	4.05
1904	4.50	4.25	4.35	4.20	4.30	4.10	4.20	4.10
1905	4.55	4.50	4.55	4.50	4.60	4.50	4.85	4.60
1906	5.75	5.50	5.75	5.75	5.75	5.75	5.75	5.75
1907	6.00	6.00	6.00	5.75	5.75	5.25	5.25	5.25
1908	4.37½	4.05	4.52½	4.32½	4.52½	4.40	4.62½	4.47½
1909	4.35	4.20	4.35	4.35	4.35	4.30	4.42½	4.27½
1910	4.37½	4.25	4.40	4.30	4.45	4.35	4.40	4.40
1911	4.47½	4.45	4.50	4.45	4.60	4.50	4.60	4.55
1912	4.20	4.15	4.50	4.20	4.75	4.50	4.85	4.47½
1913	4.50	4.35	4.40	4.35	4.55	4.40	4.85	4.50

Highest and lowest prices of lead at New York City, monthly, 1901–1913, in cents per pound—Continued.

Year.	September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.00
1902	4.10	4.05	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.40	4.10	4.40	4.35	4.40	4.10	4.25	4.10
1904	4.25	4.20	4.30	4.20	4.50	4.20	4.65	4.60
1905	4.90	4.85	5.30	4.85	5.40	5.15	5.90	5.25
1906	5.75	5.75	5.75	5.75	5.75	5.75	6.00	5.75
1907	5.25	4.75	4.75	4.75	4.75	4.00	4.10	3.35
1908	4.60	4.52½	4.47½	4.20	4.40	4.25	4.30	4.12½
1909	4.40	4.32½	4.37½	4.32½	4.40	4.32½	4.70	4.37½
1910	4.40	4.40	4.40	4.40	4.50	4.40	4.50	4.50
1911	4.55	4.50	4.50	4.25	4.50	4.25	4.47½	4.47½
1912	5.12½	4.80	5.15	5.00	5.00	4.50	4.50	4.32½
1913	4.80	4.65	4.70	4.35	4.40	4.25	4.25	4.00

PRICE CURVES.

The fluctuations in the price of lead at New York and London are graphically shown in figure 8, which gives curves of the weekly average price of lead in those markets for the years 1912 and 1913. The independence of the New York market, except beyond the limit set by the tariff differential, is manifest, as is also the striking artificiality of that market.

VALUE.

The production of primary lead from domestic ores in 1913 was 436,430 short tons, valued at $38,405,840, based on the average New York price, as compared with 415,395 tons, valued at $37,385,550, based on the average New York price, in 1912, a gain of 21,035 tons, equal to 5.06 per cent in quantity, and of $1,020,290, equal to 2.73 per cent in value. In 1911 the production was 405,863 tons, valued at $36,527,670; in 1910 it was 389,211 tons, valued at $34,250,568; in 1909 it was 363,319 tons, valued at $31,245,434; and in 1908 it was 310,762 tons, valued at $26,104.008.

CANADIAN LEAD BOUNTY.

The bounty paid by the Dominion of Canada to lead producers amounts to 75 cents per 100 pounds lead content of Canadian ore delivered to Canadian smelters when the London price of lead does not exceed £14 10s. per long ton (3.15 cents per pound). With increase in the price of lead the bounty decreases at the same ratio, ceasing altogether when lead is about £18 per long ton (3.91 cents per pound). The result of the bounty is to maintain to the producers a steady value for lead, under the present arrangement, of £18 per long ton.

Upon the termination of the first period of five years of operation of the bounty on June 30, 1908, it was renewed for a second period of five years, with the maximum and minimum London price limits each raised £2 per long ton, giving the figures cited above. The lead production of Canada is chiefly from the mines of British Columbia. Prior to the enactment of the bounty this lead was largely smelted

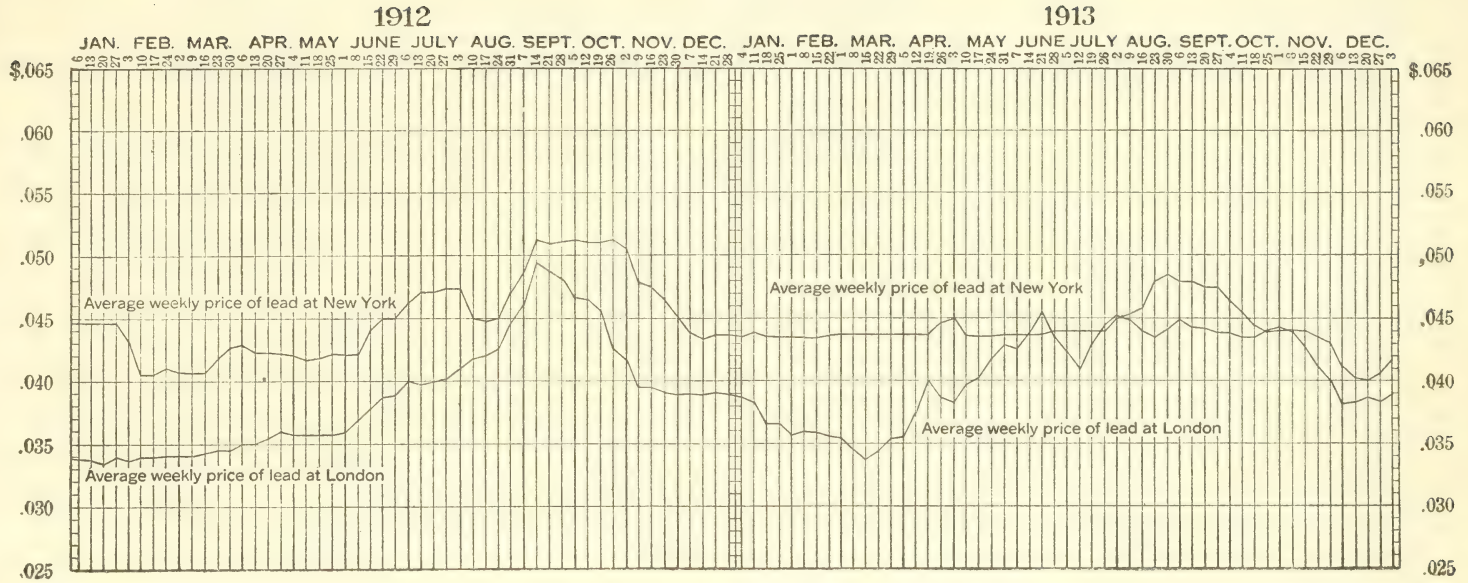

FIGURE 8.—Average weekly price of lead at New York and London, 1912–13.

and refined in the United States, but since that time the ore has been smelted in Canada.

The following figures, showing the amounts paid during several periods to March 31, 1913, are taken from the reports of the Canada department of mines:

Statement of bounties paid on lead during the fiscal years 1899 to 1913.

Year ending June 30—	Bounty paid.	Year ending March 31—	Bounty paid.
1899	$76,665	1907 (9 months)	$1,995
1900	43,335	1908	51,001
1901	30,000	1909	307,433
1902		1910	340,542
1903	4,380	1911	248,534
1904	195,627	1912	179,288
1905	330,645	1913	68,065
1906	90,196		
		Total	1,967,706

THE LEAD CONVENTION.

The lead convention, formed at Paris early in 1909, and known as the International Sales Association, became effective May 1 of that year. It is composed of Spanish, Belgian, and German producers and metal-selling companies, together with Australian and American producers who consign lead to the European markets. The principal German producer, the Braubach silver-lead works, though not a member of the association, is acting in concert. The object of the association is to eliminate price cutting and sharp fluctuations and, by the establishment of a common selling agency and the allotment of spheres of sales, to introduce economies in the sale and delivery of lead. The Metallgesellschaft is the selling agency and Frankfort on the Main the chief market for metal controlled by the association, which is said to be about half the European supply.

At the close of the first year of the convention there were rumors of dissatisfaction among the members, and many predictions were made that the association would not be renewed. However, after a period of uncertainty which forced lead down to the lowest price of the year, the convention, in May, 1910, was established for another term, and in 1913 it was continued for another three years.

That prices have been more stable and less subject to sudden fluctuations since the organization of the convention is evident. Though the first two years of the convention were not marked by any advance in prices, the first half of the third year of its operation, as may be seen by an inspection of figure 1, showed a gradual rise in the price of lead, carrying the metal to the highest point reached since the panic of 1907, while at the same time the price in the United States remained nearly stationary, or even lost a little. During the fourth year of its operation, the price of lead has several times been higher in London than in New York.

SUMMARY.

The following tabular statement gives the general items regarding domestic and world production and consumption of lead. The figures for domestic items are those compiled by this office, and the figures for the world items are based upon statistics compiled by the Metallgesellschaft.

Summary of lead statistics, 1908–1913, in short tons.

	1908	1909	1910	1911	1912	1913
Total production of refined lead in the United States	396,564	446,901	470,272	486,979	480,894	462,460
Production of desilverized lead in the United States	295,552	329,751	328,954	331,032	339,646	330,593
Production of soft lead in the United States (including desilverized soft)	130,881	149,690	169,270	191,614	171,037	161,300
Production of antimonial lead in the United States	13,629	12,896	14,069	14,078	13,552	16,665
Production of lead from domestic ores	311,666	352,839	375,402	391,995	392,517	411,878
Production of secondary lead in the United States	18,401	41,687	55,422	54,284	67,168	72,834
Consumption of lead in the United States (disregarding stocks)	324,176	367,504	397,763	353,828	394,159	414,281
World production (approximate)	1,150,517	1,164,903	1,210,504	1,227,648	1,282,513	1,270,458
World consumption (approximate)	1,157,469	1,182,212	1,209,055	1,218,914	1,279,746	1,290,499
United States (domestic) percentage of world production	27.1	30.3	31.0	32.0	30.6	32.4
United States percentage of world consumption	28.0	31.1	32.9	29.0	30.8	32.1
World rank of United States in production of lead	First.	First.	First.	First.	First.	First.
World rank of United States in consumption of lead	First.	First.	First.	First.	First.	First.

BIBLIOGRAPHY.

A list of the more important publications on lead and zinc published by the United States Geological Survey is given in the chapter on zinc in Mineral Resources for 1913.

METALS AND METALLIC ORES IN 1912 AND 1913.

By J. P. Dunlop.

INTRODUCTION.

For the calendar years 1908 and 1909 the Survey published a summary, by Waldemar Lindgren, and for 1910 and 1911, by H. D. McCaskey, of the domestic production of metals—divided into output from domestic and from foreign sources and measured for uniformity throughout by the short ton of 2,000 pounds—and of the domestic output of metallic ores by classes, measured also by the short ton. For purposes of comparison and contrast this summary filled a need not otherwise supplied, and similar data are here given for 1912 and 1913.

In the detailed chapters on the various metals in Part I of Mineral Resources of the United States (to which the reader should refer for full information on the metallic resources and industries) the production is measured in terms of the customary unit, whether the long ton of 2,240 pounds, the metric ton of 2,204.6 pounds, the short ton of 2,000 pounds, the "flask" of 75 pounds, the avoirdupois pound, or the troy ounce. The long ton is used for coal, iron ore, bauxite, pig iron, and steel, particularly in the Eastern States, and for tin, copper and spelter in England. The metric ton is used on the Continent of Europe, in Mexico, and wherever the metric system is in vogue. The "flask" is the customary unit for the measurement of quicksilver except where the metric ton is used; the avoirdupois pound is the unit referred to in defining the tons and the "flask," and is also used for measuring the output of copper, lead, spelter, aluminum, nickel, etc.; the short ton is used for both ore and concentrates in the West, as well as for lead and spelter; and the troy ounce is used for gold, silver, and platinum and allied rare metals. Were the metric system in commercial use in the United States, this confusion of terms would be avoided; in its absence the production of this country by metal mines and metallurgical plants is summarized, as stated, in terms of the short ton of 2,000 pounds.

The table of metal production gives in the main the output from plants—mills, smelters, refineries—in the United States, and is essentially a measure of the metallurgical industry, as the supplies of ore, matte, unrefined bullion, etc., treated in this country are from both domestic and foreign sources. The attempt is made at subdivision of these two, however, and the production in marketable form of metals from both domestic and foreign mines is therefore given wherever possible. The table of domestic ore production is a measure of the metal-mining industry of the United States alone.

There are, roughly, four stages to be considered in the production of metal in marketable form from crude ore: (1) Mining, (2) milling and concentrating, (3) smelting, and (4) refining. The first stage

produces crude ore; and both straight concentrating and gold and silver milling plants produce concentrates. Both crude ore and concentrates are treated in both gold and silver amalgamating, cyaniding and chlorinating plants, and also in smelters, and the products are refined in private refineries and the precious metals in part in the United States mints. As production may be reported, therefore, as metal in raw materials, in unrefined state, or as refined, there may be three sets of figures to represent the metal output, and there may be certain discrepancies between these for the same metal for the same calendar year, owing to time difference, customary losses in metallurgical operations, and difference in activity between mining and treating the ore. In this summary the metals are measured as refined.

METALS.

The following tables show the production of metals in the United States in 1912 and 1913:

Production of metals in the United States in 1912 and 1913, in short tons.

1912.

Metal.	Production from domestic ores.		Production from foreign ores, matte, and unrefined bullion smelted or refined in the United States.		Total production.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Iron (pig)[a]	32,458,938	$402,378,453	1,343,747	$18,184,935	33,802,685	$420,563,388
Manganese (spiegeleisen and ferromanganese)[b]	114,868	1,962,955	140,423	6,319,051	255,291	8,282,006
Other ferro-alloys[b]	109,202	1,901,707	3,633	2,040,063	112,835	3,941,770
Nickel[c]			22,421	17,936,800	22,421	17,936,800
Aluminum[d]	32,803	15,089,380			32,803	15,089,380
Gold	154.996	93,451,500	33.112	19,964,010	188.108	113,415,510
Silver	2,186.291	39,197,500	2,285.147	40,989,817	4,471.438	80,187,317
Platinum	.032	23,003	1.318	1,709,218	1.350	1,732,221
Quicksilver	939.900	1,057,180			939.900	1,057,180
Tin			8.400	8,850	8.400	8,850
Copper, stated as refined	601,838	198,606,540	132,214	43,630,620	734,052	242,237,160
Lead, stated as refined	392,517	35,326,530	88,377	7,953,930	480,894	43,280,460
Antimonial lead	8,549	826,788	5,003	484,560	13,552	1,311,348
Zinc, stated as spelter	323,907	44,699,166	14,899	2,056,062	338.806	46,755,228
Total		834,520,702		161,277,916		995,798,618

1913.

Iron (pig)[a]	32,642,438	$439,633,756	1,393,169	$18,708,589	34,035,607	$458,342,345
Manganese (spiegeleisen and ferromanganese)	119,818	2,468,713	133,834	6,803,556	253,652	9,272,269
Other ferro-alloys[b]	75,835	2,184,965	2,265	1,558,128	78,100	3,743,093
Nickel[c]			23,562	18,849,600	23,562	18,849,600
Aluminum[d]	36,190	13,845,000			36,190	13,845,000
Gold	146.278	88,884,400	32.025	18,619,535	178.303	107,503,935
Silver	2,290.337	40,348,100	1,738.583	30,628,049	4,028.920	70,976,149
Platinum and allied metals	.035	46,530	1.342	1,761,930	1.377	1,808,460
Quicksilver	758	813,171			758	813,171
Tin	2.5	2,250			2.5	2,250
Copper, stated as refined	618,412	191,707,720	189,122	58,627,820	807,534	250,335,540
Lead, stated as refined	411,878	36,245,264	50,582	4,451,216	462,460	40,696,480
Antimonial lead	14,667	1,398,971	1,998	192,883	16,665	1,591,854
Zinc, stated as spelter	337,252	37,772,224	9,424	1,055,488	316,676	38,827,712
Total		855,351,064		161,256,794		1,016,607,858

[a] Marketed production.
[b] Includes marketed production of ferrosilicon, ferrophosphorus, ferrovanadium, ferrotungsten, ferromolybdenum, ferrotitanium.
[c] Nickel content of imported matte and ore.
[d] Includes foreign. Figures are consumption, not production.

Pig iron.—The production of pig iron is usually reported by long tons. The output of 1911 was 23,257,288 long tons, for 1912 it was 30,180,969 long tons, and for 1913 it was 30,388,935 long tons.

Manganese (spiegeleisen and ferromanganese).—The figures for the important iron-manganese alloys were formerly published by the Survey, combined with those of pig iron. Statistics for their total marketed production are now available separately. The production for both alloys is given as 178,615 long tons in 1911, 227,939 long tons in 1912, and 226,475 long tons in 1913.

Ferrosilicon and ferrophosphorus.—The combined marketed production of ferrosilicon and ferrophosphorus was 70,122 long tons in 1911, 97,371 long tons in 1912, and 67,164 long tons in 1913.

Other ferro-alloys.—In addition to spiegeleisen, ferromanganese, ferrosilicon, and ferrophosphorus are the ferro-alloys known as ferromolybdenum, ferrotitanium (with 10 to 20 per cent of titanium), ferrovanadium, ferrotungsten (with about 50 per cent of tungsten). The combined output in 1911 was 4,638 long tons, in 1912 it was 3,375 long tons, and in 1913 it was 2,568 long tons.

Nickel.—The production of nickel in the United States from domestic ores is merely a by-product from electrolytes of the copper refineries. A comparatively small output of nickel salts was recovered from domestic ores in 1912 and 1913, but the quantity is not known. The figures for 1912 and 1913 given in the table are for content of nickel in ore and matte "imported for consumption," and are mostly from the Canadian (Sudbury) deposits.

Aluminum.—There is only one producer of aluminum in the United States. The figures given are those for consumption. The statistics are usually reported in pounds and show 47,734,000 pounds for 1910, 46,125,000 pounds for 1911, 65,607,000 pounds for 1912, and 72,399,000 pounds for 1913. The figures include the consumption of the imported metal as well as the domestic.

Gold and silver.—The production of gold and silver is usually given in fine ounces troy. The following table gives the output of domestic plants for 1912 and 1913:

Production of gold and silver in 1912 and 1913, in fine ounces troy.

	Domestic.	Foreign.	Total.
Gold:			
1912	4,520,717	965,759	5,486,476
1913	4,299,783	900,720	5,198,503
Silver:			
1912	63,766,800	66,650,109	130,416,909
1913	66,801,500	50,708,690	117,510,190

The unrefined foreign gold and silver come mainly from Canada, Mexico, Central America, and South America, and considerable ore from which gold and silver are by-products of the smelters in base bullion is also received by domestic plants chiefly from these countries.

Platinum.—The production is usually reported in troy ounces, and the domestic output is from crude platinum from gravels in Oregon and California, from copper-platinum-palladium ore from the Rambler mine in Wyoming, and also from refined metal recovered as a by-

product in refining gold and copper bullion from both domestic and foreign ores, and from bullion from scrap. The figures are 505 and 500 troy ounces, respectively, for 1912, and 384 and 650 troy ounces, respectively, for 1913. The quantity of refined platinum derived from foreign ores and bullion amounted to 37,524 troy ounces in 1912, and to 39,154 troy ounces in 1913.

Quicksilver.—The domestic production of quicksilver is entirely from domestic ores and is usually reported in flasks of 75 pounds each. The output was 21,256 flasks in 1911, 25,064 flasks in 1912, and 20,213 flasks in 1913.

Tin.—The production of tin is usually given in short tons. There was about 2.5 short tons of metal produced from Alaska ores. The estimated metallic content of the tin concentrates from domestic mines in 1913 amounted to about 168,000 pounds, nearly all the stream tin from Alaska being shipped to England for smelting. The consumption in the United States is largely supplied by imports, but also by recoveries of secondary tin from alloys, drosses, and scrap tin plate.

Copper.—The production of domestic copper is usually reported as blister copper in pounds. The output of blister copper from domestic ores was 1,097,232,749 pounds in 1911, 1,243,268,720 pounds in 1912, and 1,224,484,098 pounds in 1913. Foreign sources for copper produced and refined in the United States are Mexiço, Canada, Peru, Europe, and other countries.

Lead.—The production of lead is usually given in short tons. The imports of foreign material for treatment in domestic plants come mainly from Mexico.

Antimonial lead.—The output of antimonial lead is mainly a metallurgical by-product obtained in refining lead bullion. The only domestic antimony recovered in 1913 was from a small quantity of ore from Nevada mined in 1911.

Zinc.—The production of metallic zinc or spelter is usually stated in short tons. The figures do not include zinc in pigments. Imports of foreign ores come mainly from Mexico.

METALLIC ORES.

The following table shows the production of crude metallic ores supplied from domestic mines to gold and silver mills, concentrating plants, and smelters:

Production of crude metallic ores from domestic mines in 1911, 1912, and 1913, in short tons.

	1911	1912	1913
Iron ores	46,023,540	63,859,728	66,800,270
Manganese ores	2,752	1,864	4,534
Manganiferous iron ores	3,006	3,247	10,908
Chromium ores	134	225	286
Tungsten ores	16,500	34,000	34,100
Titanium ores		6,900	7,600
Aluminum ores	174,292	179,049	235,470
Gold ores	9,884,684	9,736,203	9,403,622
Silver ores	739,200	848,574	1,253,116
Quicksilver ores	138,525	155,693	136,278
Tin ores	42,200	3,000	7,500
Vanadium and uranium ores	8,468	18,000	27,900
Antimony ores			116
Copper ores:			
Western States	18,207,566	23,431,301	28,427,543
Central States	10,978,827	11,411,941	7,016,831
Eastern States	801,842	830,089	892,308
Total	29,988,235	35,673,331	36,336,682
Copper-lead ores	6,923	14,614	24,399
Lead ores:			
Western States	2,157,817	2,388,598	2,563,904
Central States	3,794,712	4,064,366	4,250,800
Total	5,952,529	6,452,964	6,814,704
Zinc and zinc-lead ores:			
Western States	1,356,781	1,344,222	1,658,486
Central States	10,629,269	11,899,185	10,767,340
Eastern States	413,332	497,832	692,348
Total	12,399,382	13,741,239	13,118,174
Grand total	105,380,370	130,728,622	134,215,858

Iron ore.—Under iron ores are included 477,920 long tons of manganiferous iron ores (with low manganese content) in 1911, 816,984 long tons in 1912, and 612,743 long tons in 1913 shipped from Lake Superior mines. The Lake Superior and Clinton hematites are usually shipped without concentration, although there is a movement now growing important to wash and concentrate some Lake ores. The eastern brown ores are usually washed to remove clay. The magnetites of New York are in part concentrated to remove apatite. All these ores are reported in the table as shipped or smelted.

Manganese ore.—The production of high-grade manganese ore is mainly from Virginia, but the figures given include some output from California and South Carolina in 1912 but not in 1913. The principal uses of manganese ores are for the manufacture of iron-manganese alloys, as fluxes in smelting, as oxidizing and decolorizing agents, for making dry cells, and for coloring glass, brick, and pottery.

Manganiferous iron ore.—The low-grade manganiferous iron ores from the Lake Superior region are included with iron ores in the table. The remaining manganiferous iron ores come mainly from Arkansas and Virginia, and are used chiefly in making high-manganese pig iron. Considerable quantities of manganiferous and iron ores, usually argentiferous, are mined in Colorado and elsewhere and are used as fluxes in western lead smelters; they are included under ores of the precious metals.

Chromium ore.—Chromic iron ore or chromite is usually reported in long tons. The output, used chiefly to supply pigments, in special

tanning processes, for furnace linings, and in steel alloys, was 205 long tons in 1910, 120 long tons in 1911, 201 long tons in 1912, and 255 long tons in 1913, all from California mines. The imports in 1912 were 53,929 long tons, and in 1913, 65,180 long tons, chiefly from Rhodesia, New Caledonia, and Russia.

Tungsten ore.—Tungsten ore is usually reported in short tons, and the production reported in the table is in part estimated and includes output from reworking of some hundreds of tons of old tailings. The ordinary commercial basis for tungsten ores in the United States is a content of 60 per cent tungsten trioxide. The production of tungsten in 1913 was 1,537 short tons of 60 per cent WO_3, valued at $672,118. The metal is chiefly used for making high-speed steels and the filament of the tungsten incandescent electric lamp, although the total requirement for this last-named purpose is relatively small.

Vanadium ore.—Production of vanadiferous ores was confined to carnotite and roscoelite ores. The output could not be reported separately for 1910 or 1911 and is given combined with that of uranium ore (carnotite) in the tables for 1912 and 1913. The estimated quantity of ores produced in 1913 amounted to 27,900 short tons, containing 34.8 short tons of metallic uranium, valued at $133,714. From this ore and from other sources there was also derived 432 short tons of vanadium, valued at $518,400.

Titanium ore.—The domestic output of titanium ore has been mainly rutile from Virginia and amounted to 275 tons of metal in 1912 and in 1913. The use is chiefly for making ferrotitanium for steels and titanium carbide for electrodes, and this demand is in part supplied by the use of titaniferous magnetite and ilmenite, both of which are more plentiful and cheaper than rutile.

Aluminum ore.—The figures for aluminum ore given in the table are for domestic output of bauxite. In long tons, as usually reported, the production was 148,932 long tons in 1910, 155,618 long tons in 1911, 159,865 long tons in 1912, and 210,241 long tons in 1913. The output is mainly from Arkansas, Georgia, Alabama, and Tennessee. A possible new source of aluminum is alunite, deposits of which have recently been recognized and developed in Utah and elsewhere, attention being called to them mainly as a new source for potash. The chief uses of bauxite are as raw material in production of metallic aluminum and in the manufacture of aluminum salts, bauxite bricks, and alundum (an abrasive).

Gold ore.—The figures given for gold ore include siliceous, pyritic, and other ores in which the predominant value is for gold. The domestic gold output is derived not only from gold ore, but also from gravels of placer mines. Satisfactory figures for the quantity of gravels washed are not available, but it is hoped they will be obtained by the Survey for future reports. A portion of the gold output is also derived from copper, lead, and mixed base-metal ores.

Silver ore.—The production of silver ore given is mainly of silver-gold ores in which the value of the silver exceeds that of the gold. Of the total production in 1913 Nevada (mainly Tonopah) is credited with 697,775 short tons, New Mexico with 117,098 tons, Utah with 73,294 tons, Oregon with 23,620 tons, Colorado with 274,116 tons, Texas with 21,576 tons, and Arizona with 26,330 tons. The Colorado output is largely of iron-manganese-silver ores from Leadville,

used as flux in the lead furnaces. Pure silver ore is rare. About two-thirds of the silver production of the United States is derived as a by-product of lead and copper ores.

Quicksilver ore.—No quicksilver ore is imported. Of the domestic output ore treated in 1912 included 139,347 short tons, averaging 0.55 per cent of metal in California, and 16,346 tons, averaging 1.04 per cent, in Texas and Nevada combined. In 1913 the production in California was 119,159 short tons, averaging 0.49 per cent; in Nevada 8,755 short tons, averaging 0.71 per cent; and in other States including Texas, 8,461 short tons, averaging 1.34 per cent.

Copper ore.—The copper ores of the Western States are in part concentrated and in part smelted crude. Those from Michigan are always concentrated, and those from Tennessee are smelted crude. The total quantity of copper concentrates from copper ores produced in 1910 was 2,063,824 short tons, in 1911 it was 2,202,590 tons, in 1912 it was 2,734,065 tons, and in 1913 it was 3,034,870 tons. The increase of more than 300,000 tons in 1913 was due to more extended working of low-grade ore deposits in New Mexico, Arizona, and Nevada. The average per cent of copper in crude copper ore concentrated was 1.22. A small part of the domestic copper output is derived from gold, lead, zinc, and mixed ores.

Lead ore.—The lead ores of the Western and the Central States are generally concentrated. The production of lead concentrates from the Central States, mainly from southeastern Missouri, was 260,967 short tons in 1910, 270,883 short tons in 1911, 269,433 short tons in 1912, and 260,664 short tons in 1913. The output of lead concentrates in Idaho, the largest producer in the Western States, was 233,113 short tons, and the production in Utah was 129,413 short tons in 1913.

Zinc ore.—A considerable part of the production of zinc ore is used in the manufacture of pigments. Except some western ores, which are shipped crude, the zinc ores are generally concentrated. The zinc ore and concentrates of the Eastern States in 1913 are mainly from Franklin Furnace, N. J., but also from eastern Tennessee and southwestern Virginia. The output from the Central States is chiefly from Missouri, Wisconsin, Oklahoma, and Kansas, in the order named; and that from the Western States is mainly from Colorado, Montana, Idaho, New Mexico, Utah, Nevada, Arizona, and California.

The largest producer of zinc concentrates in the Western States in 1913 was Montana. The production from the Central States in 1913 was nearly 24,000 tons less than in 1912.

The following table shows the production of zinc concentrates in 1911, 1912, and 1913:

Production of zinc concentrates in 1911, 1912, and 1913, in short tons.

	1911	1912	1913
Western States	149,000	169,857	246,720
Central States	381,579	424,337	400,881
Eastern States	257,133	304,175	300,201

GOLD, SILVER, COPPER, LEAD, AND ZINC IN IDAHO IN 1913.

(MINES REPORT.)

By C. N. Gerry.

PRODUCTION.

The value of the recoverable output of gold, silver, copper, lead, and zinc from Idaho mines in 1913 was $24,149,049, an increase of $2,682,528 over the output of 1912. In spite of a decrease in metal prices generally, there was more ore mined in the State and a far greater output of all metals except gold. In silver, lead, and zinc record outputs were made. There was an average production of gold, the decrease from that of 1912 being slight. Gold production from lode mines continued to decrease, while that from placers increased. The total value of the State output was even greater than that of 1906, when the mines were unusually productive.

Total quantity of ore sold or treated in Idaho, 1904–1913, number of producers, and content and total value of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	360	1,668,327	$1,710,365	7,666,382	5,087,518	233,096,375	2,600	$16,933,405
1905	257	1,669,038	1,075,618	8,679,093	7,321,585	259,812,428	1,228,449	19,743,620
1906	287	1,787,673	1,149,100	9,018,815	9,558,913	255,014,446	2,065,597	23,698,400
1907	359	1,690,860	1,255,911	8,415,431	10,890,731	233,823,854	6,985,732	21,793,064
1908	385	1,689,231	1,443,459	7,469,981	10,041,850	206,827,816	37,410	15,416,599
1909	324	1,772,383	1,453,822	7,041,633	9,115,489	215,986,285	1,351,010	15,660,849
1910	417	1,786,174	1,096,842	7,369,742	7,037,292	228,258,839	5,603,114	16,316,196
1911	369	2,170,897	1,372,387	8,196,136	5,152,937	272,556,525	8,340,249	19,100,894
1912	408	2,266,334	1,381,214	8,294,745	7,492,152	284,185,657	13,905,502	21,466,521
1913	384	2,451,592	1,344,559	9,989,193	9,592,966	317,871,945	23,173,953	24,149,049
Increase (+) or decrease (−) in 1913	.....	+185,258	−36,655	+1,694,448	+2,100,814	+33,686,288	+9,268,451	+2,682,528

The output as separated according to its source shows that the main increases were made in lead-zinc ore and copper ore. Production of lead ore was practically the same and that of siliceous ore was considerably less.

Output of ore and production of metals in Idaho in 1913, by kinds of ore.

Source of production.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	196	.....	33,574.81	7,309	.....	.....	.....
Dry or siliceous ore	88	60,325	22,341.27	125,839	7,358	7,503	.....
Copper ore	16	143,865	5,032.26	414,371	8,823,011	146	.....
Lead ore	76	1,598,344	3,404.44	7,806,445	624,089	267,685,316	77,795
Zinc ore	10	2,978	6.00	2,619	272	6,692	2,295,707
Lead-zinc ore	9	646,080	684.26	1,632,610	138,236	50,172,288	20,800,451
Total	.....	2,451,592	65,043.04	9,989,193	9,592,966	317,871,945	23,173,953

ORE PRODUCTION IN 1913.

The quantity of ore sold or treated increased from 2,266,334 tons in 1912 to 2,451,592 tons in 1913, an increase of 185,258 tons or 8.17 per cent. Lead ore represented 1,598,344 tons, or 65.20 per cent of the total. This is nearly the same as the amount of lead ore produced in 1912. The increase came largely in lead-zinc ore, and amounted to 646,080 tons, or 26.35 per cent. The output of copper ore increased to 143,865 tons, or 5.87 per cent of the total, and that of siliceous ore decreased to 60,325 tons, or 2.46 per cent of the total. There was very little straight zinc ore produced, as most of the spelter came from the separation of lead-zinc ore. All the ore as mined averaged $2.72 in gold and silver; siliceous ore, $8.92; copper ore, $2.46; lead ore, $2.99; zinc ore, $0.57; and lead-zinc ore, $1.55. The production of siliceous ore included 36,729 tons of gold ore, in which the value of the gold was over four times that of the silver; 23,390 tons of gold and silver ore, in which the value of the gold was nearly equal to that of the silver; and 206 tons of silver ore, in which the chief value was that of silver. The gold ore averaged 0.41 ounce of gold and 0.32 ounce of silver per ton; the gold and silver ore, 0.31 ounce of gold and 4.20 ounces of silver; and the silver ore, 0.135 ounce of gold and 74.60 ounces of silver.

Subdivision of tonnage of ore sold or treated in Idaho in 1913, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Ada	2,264	.....	.....	.....	.....	2,264
Adams	19	155	.....	.....	.....	174
Bear Lake	.....	55	.....	.....	.....	55
Blaine	39	3	1,697	259	17,154	19,152
Boise	11,483	.....	.....	.....	.....	11,483
Bonner	144	105	4,762	.....	.....	5,011
Cassia	.....	.....	31	.....	.....	31
Clearwater	20	.....	.....	.....	.....	20
Custer	2,416	37,737	3,785	.....	.....	43,938
Elmore	1,158	.....	.....	.....	.....	1,158
Fremont	.....	.....	18,223	.....	.....	18,223
Idaho	2,565	91	.....	.....	.....	2,656
Lemhi	14,454	17	18,185	.....	.....	32,656
Owyhee	25,545	.....	.....	.....	.....	25,545
Shoshone	218	105,702	1,551,661	2,719	628,926	2,289,226
Total	[a] 60,325	143,865	1,598,344	2,978	646,080	2,451,592

[a] Includes 36,729 tons of gold ore, 23,390 tons of gold and silver ore, and 206 tons of silver ore.

Only 2.19 per cent of the ore, or 53,630 tons, was treated in mills equipped for cyanidation or amalgamation. This class of ore has been decreasing for several years. Through the operation of these plants bullion was recovered valued at $424,788 for the gold and silver, or $7.58 per ton of ore and tailings treated. Most of the tonnage cyanided, 25,372 tons of ore and 2,415 tons of old tailings, came from Owyhee and Lemhi counties, and the material treated by amalgamation, 28,258 tons, was mined principally in Boise, Ada, and Idaho counties. During 1913 about 254 pounds of mercury was consumed, against 700 pounds in 1912, and 94,475 pounds of potassium cyanide, against 161,156 pounds in 1912. The consumption was 0.019 pound of mercury and 3.40 pounds of potassium cyanide per ton of material treated.

Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Idaho in 1913, by counties.

County.	Quantity of ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Ada	2,264	40.44	23	.....	.....	$850
Blaine	5	3.41	9	.....	.....	75
Boise	[a] 11,468	2,883.83	605	.....	.....	59,979
Bonner	40	30.33	11	.....	.....	634
Clearwater	20	14.51	4	.....	.....	303
Custer	1	100.95	61	[b] 328.28	[b] 1,054	9,546
Elmore	1,158	129.87	55	250.41	175	8,000
Idaho	[c] 2,552	904.59	292	8.98	1	19,062
Lemhi	[d] 10,445	3,066.68	269	1,673.03	1,623	99,122
Owyhee	[e] 25,534	1,177.95	3,726	6,829.70	94,603	224,924
Shoshone	143	109.53	49	.....	.....	2,293
Total	53,630	8,462.09	5,104	9,090.40	97,456	424,788

[a] Also yielded 443 tons of concentrates.
[b] Produced from 2,415 tons of old tailings.
[c] Also yielded 48 tons of concentrates.
[d] Also yielded 1 ton of concentrates.
[e] Also yielded 1 ton of concentrates. These tonnages and metal content are included in table of concentrates produced.

Most of Idaho's ore production, 86.74 per cent, or 2,126,535 tons, was milled in concentration plants. This ore, with some old tailings and a little ore treated in gold mills, resulted in 269,400 tons of concentrates which had a total value of $16,166,913, or an average value per ton of $60.01. The ratio of concentration was 8.22 to 1. Concentrates were made principally in Shoshone County—the Coeur d'Alene region—with Fremont and Blaine counties following. Lead concentrates, in output of which there was a good increase, represented nearly 87 per cent of the total, whereas zinc concentrates increased from 18,573 tons in 1912 to 30,311 tons in 1913.

Mine production of gold, silver, copper, lead, and zinc from Idaho concentrates in 1913.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Blaine	2,530	2,913	59.52	60,643	6,354	572,342	1,641,527	$155,952
Boise	.....	443	1,440.76	3,601	816	777	.....	32,119
Bonner	4,746	355	.26	4,877	111	510,579	.....	25,433
Fremont	15,327	4,862	.....	25,220	.....	5,199,966	.....	244,032
Idaho	.....	48	223.18	212	.....	.....	.....	4,742
Lemhi	.....	1	8.00	4	.....	.....	.....	167
Owyhee	.....	1	8.00	17	.....	205	.....	184
Shoshone	2,103,932	260,777	2,531.97	6,626,395	2,715,285	230,668,285	19,273,670	15,704,284
Total	2,126,535	269,400	4,271.69	6,720,969	2,722,566	236,952,154	20,915,197	16,166,913

By kinds of concentrates.

Dry or siliceous	494	1,684.92	3,836	816	982	.....	.....	37,317
Copper	5,482	63.90	140,478	2,235,836	.....	.....	.....	432,725
Lead	233,113	2,495.27	6,528,930	480,895	236,610,679	.....	.....	14,480,464
Zinc	30,311	27.60	47,725	5,019	340,493	20,915,197	.....	1,216,407

It is interesting to note the gradual improvement, especially in lead concentrates and zinc concentrates, in the following table, which gives the content of each kind. A correction has been made in the figures for 1912 when the lead concentrate and zinc concentrate from lead-zinc ore were not separated.

Kinds of concentrates and average metallic content of each kind produced in Idaho in 1911–1913.

Kind and source of concentrates.	Quantity.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:							
Gold and silver mills—	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1911	689	$51.00	46.82	0.06	0.70	.....	$76.61
1912	263	81.16	43.91	.39	3.24	.....	112.37
1913	493	70.44	7.78	.08	.10	.....	75.48
Concentration mills—							
1911	793	9.62	3.93	.15	.02	.....	12.08
1912	157	42.50	4.04	.15	1.00	.....	46.38
1913	1	103.00	2.00	.....	.....	.....	104.00
Copper:							
Concentration mills—							
1912	842	.41	22.33	20.35	.....	.....	81.30
1913	5,482	.24	25.63	20.39	.....	.....	78.93
Lead:							
Gold and silver mills—							
1911	8	45.00	12.50	.....	10.24	.....	60.88
Concentration mills—							
1911	209,060	.26	24.81	.14	48.69	.....	57.58
1912	212,512	.25	25.24	.11	48.82	.....	60.08
1913	233,113	.22	28.00	.10	50.75	.....	62.12
Zinc:							
Concentration mills—							
1911	12,198	.....	.....	.....	.....	33.98	38.74
1912	18,573	.01	.35	.01	.21	35.94	50.04
1913	30,311	.02	1.57	.01	.56	34.50	40.13

Of the total tonnage 7.40 per cent, or 181,414 tons, was first-class ore shipped to smelting plants. Nearly all of this was shipped to plants outside the State. Shoshone, Custer, Fremont, and Blaine counties supplied the main part of this shipping ore, which had a total value of $6,858,880, or an average of $37.81 per ton. There were increases of both siliceous ore and zinc ore shipped, but decreases in copper ore and lead ore. These were more than compensated for by the greater tonnage of concentrates. Nearly 60 per cent of the crude ore smelted was lead ore. Combining crude ore and concentrates smelted, smelting plants received material containing recoverable metals valued at $23,025,793.

Mine production of gold, silver, copper, lead, and zinc from Idaho crude ore shipped to smelters in 1913.

By counties.

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Adams	174	10.79	1,719	89,819	.....	.....	$15,183
Bear Lake	55	.....	57	4,362	.....	.....	710
Blaine	1,411	156.84	35,974	3,649	561,978	116,861	56,807
Boise	15	37.73	477	.....	599	.....	1,094
Bonner	225	23.98	12,712	27,040	5,907	.....	12,625
Cassia	31	22.49	332	351	19,919	.....	1,596
Custer	41,522	4,795.37	170,540	4,265,411	1,616,048	.....	934,380
Fremont	2,896	.....	11,584	.....	2,982,880	.....	138,244
Idaho	104	16.55	1,403	36,831	.....	.....	6,899
Lemhi	22,211	3,456.30	210,892	60,323	9,659,763	.....	633,206
Owyhee	11	52.67	2,046	5	36	.....	2,328
Shoshone	112,759	1,071.33	2,710,619	2,382,609	66,072,661	2,141,895	5,055,808
Total	181,414	9,644.05	3,158,355	6,870,400	80,919,791	2,258,756	6,858,880

By kinds of ore.

Dry or siliceous	4,250	3,103.86	19,443	6,542	6,521	.....	77,207
Copper	67,317	4,968.38	273,893	6,587,175	146	.....	1,289,155
Lead	106,980	1,565.83	2,864,080	276,411	80,906,432	.....	5,365,000
Zinc	2,867	5.98	939	272	6,692	2,258,756	127,518

Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Idaho in 1911–1913.

Kind of crude ore.	Quantity of ore.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
1911	940	$16.02	18.42	0.38	0.39	.....	$27.08
1912	1,398	20.80	13.52	.28	.....	.....	30.32
1913	4,250	15.10	4.57	.08	.08	.....	18.17
Copper:							
1911	40,061	2.32	6.34	4.96	.....	.....	18.08
1912	82,707	.50	5.24	3.82	.....	.....	16.34
1913	67,317	1.53	4.07	4.39	.....	.....	19.15
Lead:							
1911	95,840	.36	25.23	.30	35.97	.....	46.85
1912	108,986	.32	20.44	.15	35.13	.....	45.01
1913	106,980	.30	26.77	.13	37.81	.....	50.15
Zinc:							
1911	50	.....	1.98	.....	.....	35.28	41.26
1912	736	.....	.....	.....	.....	37.67	51.99
1913	2,867	.04	.33	.....	.12	39.39	44.48
Copper-lead:							
1912	1	.....	7.00	9.10	8.50	.....	42.00
Lead-zinc:							
1911	41	1.97	8.32	.....	21.05	18.41	46.32

In the following table the crude ore shipped to smelters has been classified approximately into the oxidized and sulphide ores:

Oxidized and sulphide crude ores, by kinds, including mixed dry ores and carbonate ores, produced in Idaho and shipped to smelters in 1913.

Kind of ore.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	4,250	3,103.86	19,443	6,542	6,521	.....	$77,207
Copper:							
Oxidized	27,166	1,436.79	82,006	3,117,652	9	.....	562,469
Sulphide	40,151	3,531.59	191,887	3,469,523	137	.....	726,686
Lead:							
Oxidized	18,752	416.50	230,415	42,516	9,532,791	.....	573,813
Sulphide	88,228	1,149.33	2,633,665	233,895	71,373,641	.....	4,791,187
Zinc:							
Sulphide	2,867	5.98	939	272	6,692	2,258,756	127,518
Total	181,414	9,644.05	3,158,355	6,870,400	80,919,791	2,258,756	6,858,880

Oxidized and sulphide crude ores, averages per ton, by kinds, produced in Idaho and shipped to smelters in 1912–13.

Kind of ore.	Quantity of ore.	Average metallic content.					
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1912	1,398	$20.80	13.52	0.28	0.28	.....	$30.32
1913	4,250	15.10	4.57	.08	.08	.....	18.17
Copper:							
Oxidized—							
1912	48,176	.64	5.28	4.08	.01	.....	17.37
1913	27,166	1.09	3.02	5.74	.....	.....	20.70
Sulphide—							
1912	34,531	.32	5.17	3.45	.....	.....	14.90
1913	40,151	1.82	4.78	4.32	.....	.....	18.10
Lead:							
Oxidized—							
1912	23,884	.50	12.15	.18	27.43	.....	33.26
1913	18,752	.46	12.29	.11	25.42	.....	30.60
Sulphide—							
1912	85,102	.27	22.76	.14	37.29	.....	48.31
1913	88,228	.27	29.85	.13	40.45	.....	54.30
Zinc:							
Sulphide—							
1912	736	.....	.....	.....	.....	37.67	51.99
1913	2,867	.04	.33	.....	.12	39.39	44.48
Copper-lead:							
Sulphide—							
1912	1	.....	7.00	9.10	8.50	.....	42.00
Total, 1912	193,828	.55	13.83	1.72	19.76	.14	32.70
1913	181,414	1.10	17.41	1.89	22.30	.62	37.81

GOLD.

The production of gold was 65,043.04 ounces, valued at $1,344,559, in 1913, against 66,816.23 ounces, valued at $1,381,214, in 1912, a decrease of $36,655 for 1913. For the first time in many years gold production from placers exceeded that from deep mines. Gold valued at $694,053 came from 196 placers and gold valued at $650,506 came from 188 deep mines in 1913. Nearly 81 per cent of the placer gold was won by dredges, less than 1 per cent by drifting, and the remainder by hydraulic or sluicing methods. Of the total gold output, 51.6 per cent came from placers, 34.4 per cent had its source in dry or siliceous ores, 7.7 per cent in copper ore, 5.2 per cent in lead ore, and

1.1 per cent in lead-zinc ore. An average of $7.65 in gold per ton was recovered from siliceous ores, $0.72 from copper ore, and $0.04 from lead ore. Fine gold valued at $4,693 was recovered from Snake River. Only 17,552.49 ounces in gold, or 27 per cent of the total, was recovered at gold and silver mills, against 27,015.89 ounces in 1912. Of this total, 8,462.09 ounces were recovered by amalgamation and 9,090.40 ounces by cyanidation, an average of $6.19 for the former and $6.76 for the latter. Concentrates contained 4,271.69 ounces, or 6.57 per cent of the total gold production, which gives an average of $0.33 per ton. Crude ore contained 9,644.05 ounces, or 14.83 per cent of the total gold, or an average of $1.10 per ton. Boise and Lemhi counties have become the leading gold producers, as a result of dredge operations.

Source of gold production in Idaho, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Ada	97.62	40.44					138.06
Adams	10.16		10.79				20.95
Bingham	58.20						58.20
Blaine	1.69	60.48	.05	135.70	6.00	17.54	221.46
Boise	25,633.57	4,362.32					29,995.89
Bonner	4.79	51.32	3.01	.24			59.36
Bonneville	220.01						220.01
Cassia				22.49			22.49
Clearwater	526.27	14.51					540.78
Custer	191.85	429.22	4,792.28	3.10			5,416.45
Elmore	223.68	380.28					603.96
Fremont	4.98						4.98
Gooding	9.24						9.24
Idaho	909.26	1,146.30	7.00				2,062.56
Kootenai	84.37						84.37
Latah	21.77						21.77
Lemhi	5,162.29	7,673.56	2.27	528.18			13,366.30
Owyhee	70.92	8,068.32					8,139.24
Power	57.66						57.66
Shoshone	241.78	114.52	216.86	2,714.73		666.72	3,954.61
Twin Falls	44.70						44.70
Total	33,574.81	[a] 22,341.27	5,032.26	3,404.44	6.00	684.26	65,043.04

[a] Includes 15,074.89 ounces from gold ores, 7,238.56 ounces from gold and silver ores, and 27.82 ounces from silver ores.

SILVER.

The production of silver increased from 8,294,745 ounces, valued at $5,101,268, in 1912, to 9,989,193 ounces, valued at $6,033,473, in 1913. This is an important increase of 1,694,448 ounces, or over 20 per cent, in quantity and of $932,205 in value. There was no great change in the average price of the metal, but a considerable improvement in production from mines in the Lelande district of the Coeur d'Alene region. The greatest increases were made in silver from lead-zinc ore and lead ore. Lead ore contained over 78 per cent of the silver; lead-zinc ore, over 16 per cent; copper ore, 4 per cent; and siliceous ore, slightly more than 1 per cent. Shoshone, Lemhi, Custer, Owyhee, and Blaine are the counties producing most of the silver; but the output of Owyhee County, once so important, continues to decrease. The average per ton for the various ores as mined was as follows: Siliceous ore, 2.09 ounces; copper ore, 2.88 ounces; lead ore, 4.88 ounces; lead-zinc ore, 2.53 ounces; and zinc ore, 0.94 ounce. Bullion from gold and silver mills contained 102,560 ounces, or about 1 per cent of the total output. From concentrates 6,720,969 ounces were recovered, or over 67 per cent of the total. Crude ore

supplied 3,158,355 ounces, or 31.6 per cent of the total. Concentrates averaged 24.95 ounces per ton, and crude ore 17.41 ounces.

Source of silver production in Idaho, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Ada	23	23					46
Adams	2	386	1,333				1,721
Bear Lake			57				57
Bingham	3						3
Blaine		566	22	37,926	2,619	55,493	96,626
Boise	6,259	4,683					10,942
Bonner	2	9,235	1,786	6,579			17,602
Bonneville	7						7
Cassia				332			332
Clearwater	131	4					135
Custer	79	1,115	115,832	54,708			171,734
Elmore	79	230					309
Fremont				36,804			36,804
Idaho	183	1,192	716				2,091
Kootenai	9						9
Latah	6						6
Lemhi	451	3,997	101	208,690			213,239
Owyhee	21	100,392					100,413
Power	6						6
Shoshone	46	4,016	294,524	7,461,406		1,577,117	9,337,109
Twin Falls	2						2
Total	7,309	[a] 125,839	414,371	7,806,445	2,619	1,632,610	9,989,193

[a] Includes 11,780 ounces from gold ores, 98,422 ounces from gold and silver ores and 15,637 ounces from silver ores.

COPPER.

The production of copper increased from 7,492,152 pounds, valued at $1,236,205, in 1912 to 9,592,966 pounds, valued at $1,486,910, in 1913. The increase of 2,100,814 pounds was largely the result of shipments from Custer and Shoshone counties, principally the former. The Empire Copper Co. shipped much more ore, the Lost Packer smelter was operated a short time, and the Snow Storm mine had a good output. Copper ores produced 92 per cent of the total; lead ores, 6.5 per cent; and lead-zinc ores, about 1.5 per cent. More copper ore was concentrated than in 1912, resulting in a recovery in concentrates of 2,722,566 pounds of copper, or 28 per cent of the total. Crude ore contained 6,870,400 pounds, or 72 per cent of the total. Copper ore as mined averaged 61.33 pounds per ton of recoverable copper and lead ore 0.39 pound per ton.

Source of copper production in Idaho, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Adams	555	89,264				89,819
Bear Lake		4,362				4,362
Blaine	104	454	4,848	272	4,325	10,003
Boise	816					816
Bonner	4,956	22,084	111			27,151
Cassia			351			351
Custer		4,265,411				4,265,411
Idaho		36,831				36,831
Lemhi	56	2,929	57,338			60,323
Owyhee	5					5
Shoshone	866	4,401,676	561,441		133,911	5,097,894
Total	[a] 7,358	8,823,011	624,089	272	138,236	9,592,966

[a] Includes 925 pounds from gold ores and 6,433 pounds from silver ores.

LEAD.

The record production of lead in 1913 was 317,871,945 pounds, valued at $13,986,366, against 284,185,657 pounds, valued at $12,788,355, in 1912. This increase of 33,686,288 pounds was to a great extent from Shoshone County. There was a falling off in Lemhi County, but a considerable production came from what is now Fremont County since the changing of the boundary of Blaine County. The two important sources of lead are lead ore and lead-zinc ore. The former supplied 84.21 per cent of the total, and the latter 15.78 per cent. The average per ton of the ore mined improved somewhat. The recoverable lead in lead ore averaged 8.37 per cent and in lead-zinc ore 3.88 per cent. Crude ore shipped directly to smelters supplied 80,919,791 pounds, or 25.46 per cent of the total lead output. Nearly all of this was lead ore, which averaged 37.81 per cent lead and had a value per ton of $50.15 for all metals. Over 88 per cent of this lead in crude ore shipped came from sulphide ore. Concentrates contained 236,952,154 pounds of lead, or 74.54 per cent of the total yield. The lead concentrates averaged 50.75 per cent lead and had a value of $62.12 per ton for all metals.

Source of lead production in Idaho, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Blaine	.....	62	626,168	6,692	501,398	1,134,320
Boise	1,376	.....	.....	.....	.....	1,376
Bonner	3,809	.....	512,677	.....	.....	516,486
Cassia	.....	.....	19,919	.....	.....	19,919
Custer	.....	84	1,615,964	.....	.....	1,616,048
Fremont	.....	.....	8,182,846	.....	.....	8,182,846
Lemhi	2,077	.....	9,657,686	.....	.....	9,659,763
Owyhee	241	.....	.....	.....	.....	241
Shoshone	.....	.....	247,070,056	.....	49,670,890	296,740,946
Total	[a] 7,503	146	267,685,316	6,692	50,172,288	317,871,945

[a] Includes 3,666 pounds from gold ores and 3,837 pounds from silver ores.

ZINC.

The production of zinc (estimated as spelter) increased from 13,905,502 pounds, valued at $959,479, in 1912 to 23,173,953 pounds, valued at $1,297,741, in 1913. This output far surpasses all previous records and shows an increase of 9,268,451 pounds in quantity and of $338,262 in value, largely from Shoshone County. Of the total spelter, 89.76 per cent came from lead-zinc ore and 9.91 per cent from zinc ore. From crude ore shipped 2,258,756 pounds of spelter was produced, or 9.75 per cent of the total. This product came almost all from the Beaver, Summit, and Lelande districts of Shoshone County, averaged 39.39 per cent spelter, and was all sulphide. From zinc concentrates 20,915,197 pounds of spelter, or 90.25 per cent of the total, was obtained. These concentrates came principally from lead-zinc ore mined in Beaver, Hunter, and Placer Center districts and averaged 34.50 per cent spelter. Various flotation methods are being adopted.

Source of zinc (spelter) production, by kinds of ore, in Idaho in 1913, by counties, in dry pounds.

County.	Lead ore.	Zinc ore.	Lead-zinc ore.	Total.
Blaine		153,812	1,604,576	1,758,388
Shoshone	77,795	2,141,895	19,195,875	21,415,565
Total	77,795	2,295,707	20,800,451	23,173,953

REDUCTION PLANTS.

In 1913 there were 73 milling plants in operation in Idaho, many of which were run for only short periods. There were 29 concentration plants, 26 mills using amalgamation, 12 mills using both amalgamation and concentration, 4 mills using cyanidation, and 2 mills using both amalgamation and cyanidation. In 1912 there were 59 active mills. Most of the smelting was done outside the State, but one copper-matting plant was active a short time at the Lost Packer mine, and one lead plant was operated at Clayton. A new lead plant was also being constructed at Clayton. A list of mills, with equipment, was given in the 1911 report. The new mills since that time are mentioned under the districts.

MINING INDUSTRY IN IDAHO IN 1913.

The total value of the State output in 1913, which was greater than that of any other year, and the totals for silver, lead, and zinc, which established new records, indicate that there was no serious interruption in the progress of mining in Idaho. Average metal prices were lower and there was a noticeable decline in gold output from lode mines, but there was such activity in the mining of lead and zinc ores that the State made a most creditable showing. The operation of dredges in Boise and Lemhi counties has counterbalanced the decrease in gold from other sources. The copper mines had a larger production than in 1912, though records of past years were not broken. Though the improvement in the silver-lead output was of most importance, the changes in the production and saving of zinc had much to do with the year's record. Flotation is being more generally used at the concentration plants. Several new milling plants were constructed during the year, especially in the Cœur d'Alene region, and two small smelting plants were active in Custer County.

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1913, by counties.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Ada	97.62	$2,018	40.44	$836	$2,854	46	$28
Adams	10.16	210	10.79	223	433	1,721	1,039
Bear Lake						57	34
Bingham	58.20	1,203			1,203	3	2
Blaine	1.69	35	219.77	4,543	4,578	96,626	58,362
Boise	25,633.57	529,893	4,362.32	90,177	620,070	10,942	6,609
Bonner	4.79	99	54.57	1,128	1,227	17,602	10,632
Bonneville	220.01	4,548			4,548	7	4
Cassia			22.49	465	465	332	201
Clearwater	526.27	10,879	14.51	300	11,179	135	82
Custer	191.85	3,966	5,224.60	108,002	111,968	171,734	103,727
Elmore	223.68	4,624	380.28	7,861	12,485	309	187
Fremont	4.98	103			103	36,804	22,230
Gooding	9.24	191			191		
Idaho	909.26	18,796	1,153.30	23,841	42,637	2,091	1,263
Kootenai	84.37	1,744			1,744	9	5
Latah	21.77	450			450	6	4
Lemhi	5,162.29	106,714	8,204.01	169,592	276,306	213,239	128,796
Owyhee	70.92	1,466	8,068.32	166,787	168,253	100,413	60,649
Power	57.66	1,192			1,192	6	4
Shoshone	241.78	4,998	3,712.83	76,751	81,749	9,337,109	5,639,614
Twin Falls	44.70	924			924	2	1
Total	33,574.81	694,053	31,468.23	650,506	1,344,559	9,989,193	6,033,473

County.	Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Ada							$2,882
Adams	89,819	$13,922					15,394
Bear Lake	4,362	676					710
Bingham							1,205
Blaine	10,003	1,550	1,134,320	$49,910	1,758,388	$98,470	212,870
Boise	816	127	1,376	61			626,867
Bonner	27,151	4,208	516,486	22,725			38,792
Bonneville							4,552
Cassia	351	54	19,919	876			1,596
Clearwater							11,261
Custer	4,265,411	661,139	1,616,048	71,106			947,940
Elmore							12,672
Fremont			8,182,846	360,045			382,378
Gooding							191
Idaho	36,831	5,709					49,609
Kootenai							1,749
Latah							454
Lemhi	60,323	9,350	9,659,763	425,030			839,482
Owyhee	5	1	241	11			228,914
Power							1,196
Shoshone	5,097,894	790,174	296,740,946	13,056,602	21,415,565	1,199,271	20,767,410
Twin Falls							925
Total	9,592,966	1,486,910	317,871,945	13,986,366	23,173,953	1,297,741	24,149,049

The operations in placer mining are shown in the following table:

Number of producing placer mines and production in Idaho in 1912 and 1913, by counties.

County.	1912						1913					
	Hydraulic.	Dredge.	Drift.	Gold.	Silver.	Total value.	Hydraulic.	Dredge.	Drift.	Gold.	Silver.	Total value.
				Value.	*Fine ounces.*					*Value.*	*Fine ounces.*	
Ada	3	....	....	$1,396	16	$1,406	3	....	....	$2,018	23	$2,032
Adams	1	....	....	104	3	106	2	....	....	210	2	211
Bingham	4	....	....	1,495	6	1,499	4	....	....	1,203	3	1,205
Blaine	4	....	....	96	2	97	1	....	....	35	.....	35
Boise	52	2	....	449,764	5,765	453,309	39	1	....	529,893	6,259	533,673
Bonner	....	....	....	.....	.....	.....	1	....	....	99	2	100
Bonneville	5	....	....	4,852	8	4,857	2	....	....	4,548	7	4,552
Clearwater	26	3	....	40,091	517	40,409	25	1	....	10,879	131	10,958
Custer	6	1	....	5,036	99	5,097	5	1	....	3,966	79	4,014
Elmore	12	....	....	4,575	68	4,617	18	....	....	4,624	79	4,672
Fremont	1	....	....	62	.....	62	1	....	....	103	.....	103
Gooding	....	....	....	.....	.....	.....	4	....	....	191	.....	191
Idaho	49	....	8	25,770	329	25,972	36	....	5	18,796	183	18,907
Kootenai	1	....	....	6,200	47	6,229	2	....	....	1,744	9	1,749
Latah	5	....	....	1,195	2	1,196	4	....	....	450	6	454
Lemhi	12	2	....	81,094	338	81,302	9	3	....	106,714	451	106,986
Lincoln	2	....	....	801	2	802	....	....	....	.....	.....	.....
Nez Perce	2	....	....	440	5	443	....	....	....	.....	.....	.....
Oneida	3	....	....	283	1	284	....	....	....	.....	.....	.....
Owyhee	10	....	....	781	15	790	8	....	....	1,466	21	1,479
Power	....	....	....	.....	.....	.....	4	....	....	1,192	6	1,196
Shoshone	15	....	2	7,542	54	7,575	11	....	1	4,998	46	5,026
Twin Falls	4	....	....	452	1	453	5	....	....	924	2	925
Total	217	8	10	632,029	7,278	636,505	184	6	6	694,053	7,309	698,468

There was a general increase in the number of producing properties, tonnage sold or treated, and value of the ores, in spite of the slightly decreased prices.

Tons of ore sold or treated, number of deep mines producing, and value of ores in Idaho in 1912 and 1913, by counties.

County.	Ore sold or treated.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1913	Increase (+) or decrease (−).	1912	1913	1912	1913	1912	1913
	Short tons.	*Short tons.*						
Ada	2,264	+ 839	7	3	$6.17	$0.38	$6.14	$0.38
Adams	174	− 29	4	2	71.93	87.25	7.66	7.25
Bear Lake	55	+ 46	1	3	66.44	12.91	1.00	.62
Blaine	19,152	+ 9,137	32	42	13.13	11.11	4.17	3.28
Boise	11,483	+ 2,163	10	9	5.88	8.11	5.83	8.10
Bonner	5,011	+ 4,758	7	7	52.35	7.72	37.79	2.35
Bonneville	.....	− 15	1	.....	46.86	.....	12.07	.....
Cassia	31	+ 31	.....	2	.....	51.48	.....	21.48
Clearwater	20	+ 7	2	1	12.92	15.15	12.92	15.15
Custer	43,938	+ 12,324	10	14	19.85	21.48	3.60	4.82
Elmore	1,158	− 4,468	8	3	10.26	6.91	10.26	6.91
Fremont	18,223	+ 18,223	.....	1	.....	20.98	.....	1.22
Idaho	2,656	− 2,292	18	32	11.50	11.56	11.50	9.41
Lemhi	32,656	− 12,984	26	21	24.97	22.43	7.86	9.13
Oneida	.....	− 15	1	.....	16.46	.....	.33	.....
Owyhee	25,545	− 23,656	11	12	8.48	8.90	8.48	8.90
Shoshone	2,289,226	+181,189	35	36	8.68	9.07	2.24	2.50
Total	2,451,592	+185,258	173	188	9.19	9.57	2.58	2.72

[a] Value per ton, placer product excluded.

Classifying the deep mines according to metals produced in 1913, it is found that there were 6 mines producing gold only; 2 producing silver; 69, gold and silver; 18, gold, silver, and copper; 42, gold, silver, copper, and lead; 11, gold, silver, copper, lead, and zinc; 20, gold, silver, and lead; 14 silver and lead; 5, silver, lead, and zinc; and 1, lead and zinc.

REVIEW BY COUNTIES.

ADA COUNTY.

Production was small, with decreases in gold and silver. There was a larger tonnage, but it was unprofitably treated. The output was 2,264 tons of ore, $2,854 in gold, and 46 ounces of silver. Of this amount 3 placers produced $2,018 in gold and 23 ounces of silver. Three deep mines produced only $836 in gold and 23 ounces of silver. All the ore was siliceous and treated in gold and silver mills.

Black Hornet district.—Ore from the Gray Eagle property was treated at an amalgamation mill in the neighborhood, but it was of low grade.

Highland district.—The Red Rock and other placers on Boise River produced the placer gold of the county.

ADAMS COUNTY.

Four mines produced 174 tons of ore, which yielded $433 in gold, 1,721 ounces of silver, and 89,819 pounds of copper, with a total value of $15,394. Most of the ore was a copper oxide and all of it was shipped to smelters. The average value per ton was $87.25.

Seven Devils district.—This region was comparatively quiet, the main shipper being the Blue Jacket Copper Co., at Landore. The geology of the district [1] was described in 1900.

Meadows district.—At the Rock Flat property much work was done in testing and driving a tunnel on bedrock. This placer produces sapphires as well as gold, and concentrating machinery was being installed to save the black sand and gems.

BEAR LAKE COUNTY.

Small test shipments of copper ore were made from the Bear Lake district near Paris. A report [2] on the copper deposits of this county was published by the Survey in 1910.

BINGHAM COUNTY.

From along Snake River, near Aberdeen and Sterling, placer gold was won valued at $1,203, with 3 ounces of silver.

---

[1] Lindgren, Waldemar, The copper deposits of the "Seven Devils": U. S. Geol. Survey Twentieth Ann. Rept., pt. 3, p. 249, 1900.

[2] Gale, H. S., Geology of the copper deposits near Montpelier, Bear Lake County, Idaho: U. S. Geol. Survey Bull. 430, p. 112, 1910.

BLAINE COUNTY.

Total quantity of ore sold or treated in Blaine County, Idaho, in 1904–1913, and content and total value of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	9	25,030	$3,948	488,275	.....	5,423,027	.....	$279,620
1905	18	18,845	7,152	374,554	2,312	3,983,833	1,084,449	484,966
1906	17	17,844	13,599	184,337	.....	1,737,605	10,599	236,794
1907	24	14,829	27,103	170,367	35,919	2,250,164	37,077	268,175
1908	39	7,753	2,630	126,326	31,941	1,675,124	37,410	145,912
1909	17	20,373	40,402	115,303	22,740	1,762,268	71,010	182,927
1910	23	17,042	42,335	92,596	20,018	1,284,966	76,397	155,543
1911	25	5,660	21,572	47,839	9,359	705,545	29,814	81,546
1912	36	10,015	18,630	37,797	3,516	1,819,938	105,321	131,619
1913	43	19,152	4,578	96,626	10,003	1,134,320	1,758,388	212,870
Increase (+) or decrease (−) in 1913	.....	+9,137	−14,052	+58,829	+6,487	−685,618	+1,653,067	+81,251

[a] Includes placer production.

This county increased its ore tonnage from 10,015 tons from 32 mines in 1912 to 19,152 tons from 42 mines in 1913. The average recoverable value in 1913 was $11.11, against $13.13 in 1912. The ore was classified as 17,154 tons of lead-zinc (mostly tailings), 1,697 tons of lead ore, 259 tons of zinc ore, 39 tons of siliceous ore, and 3 tons of copper ore. The first-class shipping product was 1,411 tons, valued at $56,807, or $40.26 per ton. Nearly all the remainder of the tonnage, 2,530 tons of ore and 15,206 tons of tailings, was concentrating material making 2,913 tons of concentrates, valued at $155,952, or $53.54 per ton.

Antelope district.—From Darlington a considerable tonnage of oxidized lead ore was shipped from the Weiler property, where much work was done in development and road building.

Dome district.—The boundary line between Blaine and Fremont counties was resurveyed and changed when Fremont was divided into Madison, Jefferson, and Fremont counties. As a result, the main producer of the district is now in Fremont County.

Hamilton district.—A shipment of lead ore was made from the Metta property.

Lava Creek district.—Small shipments of lead ore with some silver ore, valued at $1,642, were made from north of Martin.

Mineral Hill district.—Twenty-five deep mines produced 17,800 tons of ore and tailings containing $2,141 in gold, 75,914 ounces of silver, 7,500 pounds of copper, 815,951 pounds of lead, and 1,753,213 pounds of spelter, valued in all at $183,238, or an average of $10.29 per ton. This is a large increase over the output of 1912, which was valued at $18,934. The main reason for the increase was the treatment of tailings from the Queen mine by the Metals Milling Co., resulting in shipments of zinc concentrate and lead concentrate. The mill used was the one built for the ores of the Minnie Moore mine. Similar products were made from the ores of the Red Elephant mine. Small shipments from numerous mines and prospects made up the total, but production was meager from the old producers.

Rosetta district.—Small shipments of lead ore came from the Stormy Galore, Ladysmith, and Carrie Leonard properties.

Vienna district.—From the Webfoot property, near Pierson, a car of galena carrying gold and silver values was shipped to Salt Lake City.

Warm Springs district.—Seven deep mines produced 561 tons of ore, $1,918 in gold, 6,553 ounces of silver, 1,580 pounds of copper, 75,186 pounds of lead, and 5,175 pounds of spelter, valued in all at $9,719, or $17.32 per ton. Production was valued at $21,289 in 1912. The Independent, New Hope, Golden Glow, and Noonday contributed ore, which was largely galena.

BOISE COUNTY.

Total quantity of ore sold or treated in Boise County, Idaho, in 1904–1913, number of producers, and content and total value of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	63	17,923	$294,884	38,330	500	.....	$316,891
1905	40	1,788	152,145	1,960	.....	2,064	153,426
1906	57	16,406	229,024	4,909	.....	.....	232,313
1907	68	8,369	235,276	17,553	.....	47,903	249,400
1908	57	15,854	199,307	7,029	198	13,596	203,629
1909	65	8,705	216,031	8,484	2,185	15,410	221,390
1910	68	11,444	199,430	14,443	5,957	3,001	208,117
1911	57	17,376	353,464	7,308	5,354	2,773	358,131
1912	64	9,320	502,277	8,753	1,001	6,106	508,100
1913	49	11,483	620,070	10,942	816	1,376	626,867
Increase (+) or decrease (−) in 1913	.....	+2,163	+117,793	+2,189	−185	−4,730	+118,767

[a] Includes placer production.

Nine deep mines in Boise County in 1913 produced 11,483 tons of ore, yielding $90,177 in gold, 4,683 ounces of silver, 816 pounds of copper, and 1,376 pounds of lead, valued in all at $93,194, or $8.11 per ton. Ten deep mines in 1912 produced 9,320 tons of ore, valued at $5.88 per ton. All the ore was siliceous gold ore. At amalgamation mills 11,468 tons of ore was treated, from which bullion valued at $59,979 was recovered, or $5.23 per ton in gold and silver. This ore also produced 443 tons of concentrates, valued at $32,119. None of the mills used concentration alone and only 15 tons of ore was shipped to the smelter. The placer output reported by 40 operators was valued at $533,673, an increase of $80,364, largely due to the operations of two dredges. A Survey report[1] by Lindgren gave the geology and early statistics of this region.

Boise Basin district.—Operators of 3 deep mines and 30 placers reported the production of $615,033 in gold, 9,354 ounces of silver, and 816 pounds of copper, valued in all at $620,810, against $494,450 in 1912. Deep mines produced 11,331 tons of ore, valued at $88,784, or $7.84 per ton, all of which was treated in gold and silver mills by amalgamation. The resulting bullion contained 2,789.42 ounces of gold and 555 ounces of silver, and the concentrates—427 tons—contained 1,408.38 ounces of gold, 2,559 ounces of silver, and 816

[1] Lindgren, Waldemar, The mining districts of Idaho Basin and the Boise Ridge, Idaho: U. S. Geol. Survey, Eighteenth Ann. Rept., pt. 3, pp. 625–736, 1898.

pounds of copper. Placer output was $528,257 in gold and 6,240 ounces of silver. The Boston & Idaho Gold Dredging Co., operating two dredges on Moore and Elk creeks, was by far the largest producer, having handled over 4,000,000 cubic yards of gravel during the year. A considerable output by hydraulicking was made by the Boise Basin Improvement Co. on Mann and Hanson ground. Other important producing placers were the Harwood Glen, Clay Gulch, Leary, Crevice Diggings, and Native Missourian. Of the deep mines, the Mountain Chief and the National M. & D. Co. supplied most of the gold. A 5-stamp mill, with amalgamation plates and concentration tables, was operated the greater part of the year, the product being rather evenly divided between bullion and concentrates. The Gold Hill & Iowa Mining Co. operated a 50-ton amalgamation mill and treated considerable ore. Much development work was done and ore opened below the 500-foot level, the deepest in the region. The J. S. group on Big Muddy Creek, north of Pioneerville, produced gold ore treated in a small amalgamation mill in August.

Deadwood Basin district.—Gold and silver valued at $1,606 came from the Wilson Creek placer and Merry Blue & Union deep mine.

Hay Fork district.—A 1-stamp prospector's mill was purchased for the Hay Fork property, but operations were barely started before cold weather prevented work.

Payette River district.—Near Lardo and Thunder, a small placer production was won from the river banks.

West View district.—Four deep mines and 3 placers produced 113 tons of ore, $2,660 in gold, 1,549 ounces of silver, and 1,376 pounds of lead, valued in all at $3,657. The decrease from $10,048 in 1912 was due to idleness of the Whitman property. There was little or no work on the old producers. Some ore was milled and shipped at the Judas and Shamrock property. The Church placer ground was productive. An article [1] on the Pearl (or West View) district appeared in July in the Mining and Scientific Press.

Boise River district.—Near Twin Springs, placer gold was taken from the north bank of the river.

BONNER COUNTY.

This county produced from eight properties 5,011 tons of ore, $1,227 in gold, 17,602 ounces of silver, 27,157 pounds of copper, and 516,486 pounds of lead, valued in all at $38,792. Only one small placer produced, and the ore treated averaged $7.72 per ton in value for all metals. There was a general increase, amounting in total value to $25,568. The tonnage was divided into 4,762 tons of lead ore, 144 tons of siliceous ore, and 105 tons of copper ore. Most of the ore (4,746 tons) was concentrated, 225 tons was shipped crude, and 40 tons was amalgamated. The improvement was due to lead ore from near Clarks Fork. A recent map of the region is the Priest Lake topographic sheet of the United States Geological Survey.

Cow Creek district.—No ores were marketed from this district, which is southeast of Bonners Ferry, but a 50-ton concentration plant was being erected for the Idaho-Montana Amalgamated Co.

[1] Min. and Sci. Press, July 12, 1913, p. 66.

Lakeview district.—Only a small production came from the district, but much work was done at the Conjecture mine, installing compressor and enlarging and straightening the incline shaft.

Moyie Yahk district.—A milling output was made at the Deer Creek property northeast of Bonners Ferry.

Pend Oreille district.—Four deep mines produced 4,933 tons of ore, $460 in gold, 14,139 ounces of silver, 25,221 pounds of copper, and 514,388 pounds of lead, valued in all at $35,542. The Imperial and B. F. & H. mines produced silver ore; the Green Monarch, a copper sulphide; and the Lawrence, a lead sulphide. A 50-ton concentration plant was completed and operated in March at the Lawrence mine, which is developed by crosscut 810 feet. An unusually high grade concentrate was shipped.

Priest Lake district.—There was no output from this district, but important work was done at the Idaho Continental property west of Port Hill and north of Priest Lake. A 200-ton concentration plant and hydroelectric power plant were completed and connection was made with Port Hill by a 24-mile wagon road.

BONNEVILLE COUNTY.

The placer output was valued at $4,552 from 2 properties, against $5,560 from 5 placers and 1 deep mine in 1912.

Mount Pisgah district.—The American placer and Barnes group near Gray produced gold having a fineness of 0.970.

CASSIA COUNTY.

Stokes district.—From the Alice and Badger properties a small quantity of lead ore rich in gold was shipped to Salt Lake smelters.

CLEARWATER COUNTY.

One deep mine and 26 placers produced gold valued at $11,179 and 135 ounces of silver, a decrease of $29,079 in gold and of 384 ounces of silver.

Burnt Creek district.—Six placer properties produced $1,166 in gold and 15 ounces of silver.

Pierce district.—Twenty placers and 1 deep mine produced $10,013 in gold and 120 ounces of silver, against $37,146 in gold and 482 ounces of silver in 1912. Production, the work of a number of small operators, is evidently on the decline. The dredge of the Idaho Co. was idle, and in September the plant was destroyed by fire. The dredge of the Sprague Co. was operated part of the year, but the ground was said to be worked out.

CUSTER COUNTY.

In value of output Custer County took second place in 1913, going ahead of Lemhi County. Fourteen deep mines produced 43,938 tons of ore, which is 12,324 tons more than was produced by 10 deep mines in 1912. There were increases in all metals amounting to $315,060. The output of the county, with gold and silver from 6 placers, was $111,968 in gold, 171,734 ounces of silver, 4,265,411 pounds of copper, and 1,616,048 pounds of lead, valued in all at

$947,940. The tonnage was classified as 37,737 tons of copper ore, 3,785 tons of lead ore, and 2,416 tons of siliceous ore. One ton of exceptionally rich gold ore and 2,415 tons of old tailings were treated in gold and silver mills, yielding $9,546 in bullion. The remainder of the ore, 41,522 tons, was shipped to copper and lead smelting plants.

Alder Creek district.—Five deep mines produced 36,230 tons of ore, $39,156 in gold, 107,300 ounces of silver, 3,964,131 pounds of copper, and 66,132 pounds of lead, valued in all at $721,315. The great increase was due to shipments from the property of the Empire Copper Co., near Mackay, which is the second largest copper mine in the State. It was operated by lessees, and the old smelting plant was idle. The property is extensively developed to the 900-foot level, and a long tunnel is being driven to explore the mine at greater depth. Shipments were made from the McGinty and other claims in the district. This region is mentioned in a general report [1] on the copper mines of the United States.

Bayhorse district.—Five deep mines produced 3,525 tons of ore, $13 in gold, 53,138 ounces of silver, 838 pounds of copper, and 1,545,756 pounds of lead, valued in all at $100,251, or $28.44 per ton. All this ore was smelted either at Clayton or near Salt Lake City. Several properties, such as the South Butte or Dryden, produce a sulphide ore rich in both lead and silver. The main producer, however, in 1913, was the Red Bird Smelting Co., formerly the Idaho Smelting & Mining Co. The Red Bird property was operated 10 months and the old smelting plant for 3½ months. Lead ore was also shipped to the Salt Lake smelters after the smelter was closed. Construction was started on a new 100-ton lead plant for this property. Unlike other deposits of the district, the ore is carbonate, said to average 20 per cent lead. The geology of this district, as well as others in the vicinity, has been described in a recent report.[2]

This reports sets forth the results of a short reconnaissance in the Loon Creek, Yankee Fork, and Bay Horse mining districts, situated in the northwestern part of Custer County, Idaho. The area includes several promising ore deposits, and a few mines where a considerable tonnage is blocked out, awaiting more advantageous transportation facilities.

Loon Creek district.[3]—

The smelter at the Lost Packer mine was in operation for 24.6 days, and 1,800 tons of ore was treated, producing 380 tons of matte averaging 8 ounces of gold, 26 ounces of silver, and 45 per cent copper.

A dividend of $25,000 was paid. The ore deposits of this and other properties in the district have been described in a recent bulletin[4] of the Survey. Ore is mostly chalcopyrite developed to a depth of 1,000 feet.

Sea Foam district.—A test shipment of lead sulphide rich in silver was made from the Fisher claim. This district and the Loon Creek district are at great disadvantage since they are 113 miles from Mackay, the nearest railroad station.

Stanley Basin district.—Four placers produced $3,094 in gold and 72 ounces of silver, against $4,826 in gold and 98 ounces of silver in

[1] Weed, W. H., The copper mines of the United States in 1905: U. S. Geol. Survey Bull. 285, p. 108, 1906.
[2] Umpleby, J. B., Some ore deposits of northwestern Custer County, Idaho: U. S. Geol. Survey Bull. 539, 1913.
[3] Min. and Sci. Press, Sept. 20, 1913, p. 473.
[4] Umpleby, J. B., A preliminary account of the ore deposits of the Loon Creek district, Idaho: U. S. Geol. Survey Bull. 530, 1912.

1912. The Joes Gulch placer was active, but not as productive as formerly. The dredge of the Willis Co. was run merely as a test.

Yankee Fork district.—Two deep mines and 2 placers produced 2,416 tons of ore, $9,745 in gold, and 1,122 ounces of silver valued at $677. Tailings from the Sunbeam property were treated by cyanidation and a little rich ore from the Montana property was taken out by a lessee.

ELMORE COUNTY.

Three deep mines produced 1,158 tons of ore, $7,861 in gold, and 230 ounces of silver, valued in all at $8,000. Placers—18 in number—produced $4,624 in gold and 79 ounces of silver. Great changes have been made in this county's output on account of inactivity at Atlanta. In 1910 the gold and silver output was valued at $189,385; in 1911, at $248,230; in 1912, at $62,354; and in 1913, at $12,672. The ore produced was all siliceous and was treated in gold and silver mills, yielding $6.91 per ton in gold and silver.

Bear Creek district.—Ten small placers and 1 deep mine produced $2,899 in gold and 55 ounces of silver. The Feather River property was operated for 110 days by the hydraulic method.

Highland district.—The Last Chance placer was worked about 50 days.

Middle Boise district.—The deep mines, the Minerva, the Bagdad Chase, and the Atlanta, were unproductive; but interesting work was done by the Boise King Placers Co. Preliminary work was described in the Engineering and Mining Journal.[1]

Neal district.—Little ore was treated at the Homestake mine of the George F. Roth Mining Co., as the mill was burned in May, 1913, and was only rebuilt and started on December 2, 1913.

FREMONT COUNTY.

With the exception of a small production of placer gold from Snake River, the output came from that part of the Dome district formerly in Blaine County, but now in Fremont since the county lines were changed. The Daisy Black group of the Wilbert Mining Co. was operated most of the year, and from 300 to 900 tons of picked ore and concentrates were shipped per month. The ore is galena containing only 2 or 3 ounces of silver per ton. From a statement to stockholders issued in May, 1914, the following excerpts are taken:

> During the period July 1, 1913, to January 15, 1914, 11,193 tons of ore were mined. Of this tonnage, 1,027 tons came from the surface quarry near the Caved Tunnel. The balance of the tonnage came from the ore shoot opened up by the North Drift from the No. 3 tunnel during February and March, 1913, with the exception of about 1,500 tons which came from the old channel on the lower intermediate level and which joins the ore shoot just referred to about 70 feet above No. 3 level. * * * The principal development during this period has been the sinking of a 45-degree incline shaft below No. 3 tunnel level near the south end of stope No. 2. Cutting of station for hoist and sinking of shaft was started in August and on May 1 the shaft was down 235 feet on the incline. At a point 150 feet down a station was cut and No. 4 level established. A crosscut was run from this station to the vein, which proved to be 50 feet to the west. Drifting on the vein has continued 45 feet toward the north and 25 feet to the south. * * * During the period of this report, the mill treated all the ore that was mined, viz, 11,193 tons, which had an average assay value of 30.5 per cent lead and 2.69 ounces silver. The mill was in operation just 200 days at an average

[1] Stevens, A. W., Hydraulic flume of the Boise King Placers Co.: Eng. and Min. Jour., Jan. 31, 1914, p. 59.

of 17.14 working hours per day. There was produced 5,301.337 tons of concentrates and pickings having an average assay value of 52.3 per cent lead and 4.54 ounces silver per ton, thus yielding in metals 5,546,118 pounds of lead and 24,080 ounces of silver. From this it will be seen that for the period the mill made an average recovery of 81.23 per cent of the lead contents and 79.98 per cent of the silver contents.

Another statement was printed in the Salt Lake Mining Review.[1] The deposit was recently described by Umpleby.[2]

GOODING COUNTY.

A few ounces of placer gold came from Snake River, near Clearlake, in what is now Gooding County, formely Lincoln County.

IDAHO COUNTY.

Total quantity of ore sold or treated in Idaho County, Idaho, in 1904–1913, number of producers, and content and total value of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	52	36,367	$301,478	6,760	.....	.....	$305,348
1905	45	28,181	217,943	5,159	.....	.....	221,059
1906	47	18,130	171,030	8,929	.....	.....	177,012
1907	59	13,427	110,747	2,180	3,043	.....	112,795
1908	68	15,778	192,934	9,907	233	.....	198,216
1909	57	25,765	205,212	7,421	.....	.....	209,071
1910	82	6,351	63,885	1,744	.....	.....	64,827
1911	65	7,147	75,296	1,338	312	.....	76,044
1912	75	4,948	82,182	1,117	.....	82	82,873
1913	73	2,656	42,637	2,091	36,831	.....	49,609
Increase (+) or decrease (−) in 1913	.....	−2,292	−39,545	+974	+36,831	−82	−33,264

[a] Includes placer production.

In the last 10 years the output of this county, principally gold and silver, has been steadily decreasing from $305,348 in 1904 to $49,609 in 1913. There were 73 properties contributing to the output in 1913, of which 41 were placers and 32 deep mines. The latter produced 2,656 tons of ore, $23,841 in gold, 1,908 ounces of silver, and 36,831 pounds of copper, valued in all at $30,702. Of this ore, 104 tons was smelted and the remainder treated in gold and silver mills. Ninety-one tons was copper ore and the rest was siliceous. Placers produced $18,796 in gold and 183 ounces of silver, a decrease from $25,770 in gold and 329 ounces of silver in 1912.

Big Creek district.—Only a small amount of bullion came from this region. Testing was going on at the Moore Bonanza or Moscow, which is reported to be a large deposit of low-grade gold ore.

Camp Howard district.—A small placer production was reported.

Clearwater district.—The Cove placer near Grangeville had a small gold output.

Cottonwood district.—Copper carbonate ore produced in 1900 was shipped to Tacoma from the Great Eastern property via Snake River and Lewiston. It averaged about 20 per cent copper and was the

[1] The Wilbert mine; Salt Lake Min. Rev., Aug. 15, 1913, p. 24.
[2] Umpleby, J. B., Lead-silver deposits of the Dome district, Idaho: U. S. Geol. Survey Bull. 540, pp. 212–222, 1914.

only important shipment of copper ore from Idaho County in the last 10 years.

Dixie district.—Three placers and 2 deep mines produced 88 tons of ore, $2,218 in gold, and 31 ounces of silver. The Poorman placer on Salmon River was operated by drifting.

Elk City district.—Five placers and 13 deep mines produced 1,731 tons of ore, $16,246 in gold, 911 ounces of silver, valued in all at $16,797, a decided decrease compared with the output of 1912. Nearly all the ore was milled and had an average value per ton of $8.86. Placer production was small, but the Golden Rule had a good output. No dredges were operated. There was not a regular deep mine bullion producer in the camp. The South Fork, a producer in 1912, was active only a short time. The main producers were the Del Rio, Hope, Last Chance, Mascot, Mineral Zone, Mother Lode, and Revenue. An article [1] on the district was published in 1913.

Florence district.—Ore was milled from the Montrose claim, and a small yield of gold was derived from placer operations. The total value was $1,064.

Marshall Lake district.—Gold valued at $1,493 and 12 ounces of silver came from Resort.

Maggie Creek district.—The Golden Rule placer near Kooskia was worked a few weeks.

Newsome district.—A small production of gold came from the Moose Creek placer.

Robbins district.—This district, near Concord, was only slightly productive. Work was done on the Jumbo and Venture, formerly the Del Rio.

Simpson district.—One deep mine and 10 small placers contributed $4,459 in gold and 23 ounces of silver from Lucile, on Salmon River. The McKinley mine has a 1-stamp mill which treated a small output of ore.

Ten Mile district.—Two deep mines and 2 placers had a gold production valued at $2,238, with 22 ounces of silver. The Tippie and Alpine placers were active and ore was milled from the Equator and Wonder properties.

Thunder Mountain district.—Gold valued at $1,610 and 48 ounces of silver came from 4 placers working over old dumps at the Dewey and Sunnyside properties.

Warren district.—Seven deep mines and 5 placers produced 125 tons of ore, $10,161 in gold, 267 ounces of silver, valued in all at $10,323, against $8,194 in 1912. Most of the gold came from the Golden Rule, Humboldt, and Buck diggings. Ore was treated from the Lucky Ben, White Monument, Universal, and Skylark claims.

KOOTENAI COUNTY.

Camas Cove district.—The Cedar Creek placer was only worked about five months.

LATAH COUNTY.

Only a small placer output came from Bald Mountain, Gold Creek, and Hoodoo districts.

[1] Flagg, A. L., The Elk City mining district: Am. Inst. Min. Eng. Trans., p. 572. 1913,

LEMHI COUNTY.

Total quantity of ore sold or treated in Lemhi County, Idaho, in 1904–1913, number of producers, and content and total value of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	34	31,746	$251,948	44,475	5,000	1,827,400	$357,984
1905	19	17,271	98,171	39,357	.....	1,796,000	206,355
1906	20	17,466	105,932	36,453	40,000	1,144,000	203,284
1907	36	12,527	84,212	50,572	52,461	1,932,356	230,496
1908	37	2,515	72,682	22,992	10,366	700,622	115,662
1909	17	19,827	129,808	5,675	46,246	132,071	144,450
1910	35	15,392	66,961	150,185	54,887	6,526,474	442,197
1911	32	35,065	121,189	383,039	390,660	16,854,922	1,131,503
1912	40	45,640	225,473	348,993	106,014	16,965,603	1,221,048
1913	33	32,656	276,306	213,239	60,323	9,659,763	839,482
Increase (+) or decrease (−) in 1913	.....	−12,984	+50,833	−135,754	−45,691	−7,305,840	−381,566

[a] Includes placer production.

With the exception of gold, there were general decreases in output from this county in 1913. Twenty-one deep mines produced 32,656 tons of ore averaging $22.43 per ton, against 26 deep mines and 45,640 tons in 1912. Twelve placers produced $106,714 in gold and 451 ounces of silver. A large part of this came from the operation of 3 dredges. Of the tonnage lead ore represented 18,185 tons; siliceous ore, 14,454 tons; and copper ore, 17 tons. Most of the ore, or 22,211 tons, was shipped directly to smelting plants. It had a total value of $633,206, or $28.50 per ton. Gold and silver mills treated 10,445 tons and the bullion recovered by amalgamation and cyanidation was valued at $99,122, or $9.49 per ton. The various districts of the county have been described in a recent Survey report.[1]

Blackbird district.—The Musgrove Mining Co. operated a cyanide mill throughout the year, and made a considerable production from this new mine. The mill, which was treating about 17 tons a day, consists of 1 Dodge crusher, 1 Lane mill, 1 cone classifier, and 2 Trent agitation tanks.

Blue Wing district.—A small test shipment of ore rich in silver was made from the Castle Rock property.

Carmen Creek district.—Development continues at the Kinney group, and a new crusher was installed. The mill was only operated a few days owing to lack of water for power.

Eldorado district.—The Bohannon Bar property, formerly worked by the hydraulic method, was operated in the latter part of the year by a new dredge equipped with buckets with a capacity of 6 cubic feet. The plant was only completed in September, at which time electric power was short. When successfully operated, this boat should greatly increase the gold output of the county, just as has the Kirtley Creek plant.

Eureka district.—On Moose Creek the Mullan dredge was active. It is a small plant using steam power.

Gibbonsville district.—From 4 placers and 2 deep mines the production was 1,121 tons of ore, $11,796 in gold, and 97 ounces of silver.

[1] Umpleby, J. B., Geology and ore deposits of Lemhi County, Idaho: U. S. Geol. Survey Bull. 528, 1913.

The Allan diggings and Hughes Creek were the main placers, and the American Development, Mining & Reduction Co. was the lode producer. In July the compressor plant and engine rooms were burned, which resulted in a curtailed output.

Indian Creek district.—The Kitty Burton was the largest deep mine gold producer in the county. A 15-stamp mill equipped for amalgamation with cyanide plant was operated most of the year.

Junction district.—Several cars of lead ore were shipped from the Leadville group of the Junction Mines Co.

Kirtley Creek district.—Except for a test on ore from the Treasure Box prospect, the Kirtley Creek Dredging Co. was the only producer. This dredge east of Salmon was active 343 days handling 100,000 cubic yards of material per month. It assisted to a considerable degree in giving the county the best gold output of ten years.

Leesburg district.—Three placers produced $2,132 in gold and 12 ounces of silver. The Richardson placer on Nappias Creek was the largest producer.

Spring Mountain district.—Several small shipments of lead ore came from this region, especially from the Red Warrior property, which was leased.

Texas district.—Five deep mines produced 21,905 tons of ore, all of which was of shipping grade, containing $71,364 in gold, 204,497 ounces of silver, 57,048 pounds of copper, and 9,492,340 pounds of lead, valued in all at $621,385, or $28.37 per ton. In 1912 ore shipped had a value of $986,534. The decrease of over one-third was due to curtailment at the Pittsburg-Idaho property during the driving of a lower tunnel to facilitate the handling of ore. The ore is mainly oxidized as the water level has not been reached. The Pittsburg-Idaho Co. was shipping an average of about 900 tons per month, against 2,000 tons per month in 1912. At the Latest Out, the rate of about 600 tons of oxidized lead ore was maintained. The Gilmore Mining Co. and Allie Mining Co. shipped much oxidized iron ore containing approximately 0.75 ounce of gold and 0.5 ounce of silver per ton. In the latter part of the year a body of gold ore was opened from the 400-foot level of the Allie, samples of which ran several hundred dollars per ton. A short article [1] on the mines at Gilmore was published in August, 1913. The mines are dealt with more fully by Umpleby.[2]

Yellow Jacket district.—From June to October cyanides were shipped from the Yellow Jacket mine, at which the new plant was operated.

Unorganized or Parker Mountain district.—The 5-stamp mill of the Parker Mining Co. was active a short period on gold ore.

NEZ PERCE COUNTY.

No output was reported from this county, but a 75-ton amalgamation and concentration mill was being constructed for the Deer Creek Mining & Milling Co. southeast of Forest.

---

[1] Nichols, Ralph, Lead-silver mines of Gilmore, Lemhi County, Idaho: Am. Inst. Min. Eng. Trans., p. 2625, 1913.

[2] Umpleby, J. B., Geology and ore deposits of Lemhi County, Idaho: U. S. Geol. Survey Bull. 528, p. 89, 1913.

OWYHEE COUNTY.

The production of gold and silver in Owhyee County, with a few pounds of copper and lead, had a value of $228,914, against $417,967 in 1912. The decrease has been marked in the last few years, since the Trade Dollar mine was closed and the De Lamar output was diminished. Twelve deep mines produced 25,545 tons of ore in 1913, all of which was siliceous, a decrease of 23,656 tons. The value per ton was $8.90 in 1913, against $8.48 in 1912. Eleven tons of rich ore was shipped to the smelter having an average value of $211.63 per ton. The rest of the ore, 25,534 tons, was milled and treated largely by the cyanide method, resulting in bullion valued at $224,924, or $8.81 per ton, and 1 ton of rich concentrates. The placer output was valued at $1,479.

Carson district.—From 12 deep mines and 4 placers, the district had an output of 25,545 tons of ore, $167,094 in gold, 100,407 ounces of silver, and a little copper and lead; valued in all at $227,751. This is a decrease from $417,343 in 1912. The greater part of the output came from the De Lamar mine, where the 150-ton cyanide plant was operated for 7 months. The mine discontinued operations at the beginning of November, after which only a small amount of prospecting was done. A considerable production of bullion came from the treatment of Ontario ore in the Rich Gulch mill. Ore was passed through a Blake crusher, a set of crushing rolls, and then through a Chilean mill fitted with 40-mesh screens. The pulp was run over copper plates through a classifier and over Isbell concentration tables. Practically all the value of the ore was recovered on the plates. Rich ore from the Black Jack claim of the Trade Dollar Co. was treated in the Addie custom mill. Other producers were the Sunnyside, Ruth, and Pauper. The Banner mine was operated, but no important milling was made. The district [1] was described by Lindgren in 1910.

Steel district.—The Meadow Creek placer near Oreana had a small placer production.

Snake River district.—The Last Chance and Sailor Creek placers on Snake River produced some fine gold.

POWER COUNTY.

Placer product valued at $1,196 was taken from Snake River near American Falls, a locality that formerly belonged to Oneida County.

SHOSHONE COUNTY.

Mine production of gold, silver, copper, lead, and zinc in Shoshone County, Idaho, in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1912	52	2,108,027	$84,430	7,558,314	4,386,403	264,552,043	13,800,181	$18,313,604
1913	48	2,289,226	81,749	9,337,109	5,097,894	296,740,946	21,415,565	20,767,410
Increase (+) or decrease (−) in 1913	.....	+181,189	−2,681	+1,778,795	+711,491	+32,188,903	+7,615,384	+2,453,806

[a] Includes placer production.

[1] Lindgren, Waldemar, The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: U. S. Geol. Survey, Twentieth Ann. Rept., pt. 3, pp. 75–256, 1900.

This table represents the production of the Coeur d'Alene region, which includes several mining districts. There were large increases in output of all metals but gold, and especially large increases in silver, lead, and zinc. The total value of the county yield was $20,767,410; an increase of $2,453,806. It is by far the most productive county of the State and in value represented 86 per cent of the State total. The ore produced by 36 deep mines was 2,289,226 tons, which is 181,189 tons more than the output by 35 deep mines in 1912. The total average value per ton increased from $8.68 in 1912 to $9.07 in 1913, and the gold and silver value from $2.24 to $2.50. Most of the ore, or 1,551,661 tons, was lead ore; 628,926 tons was lead-zinc ore; 105,702 tons, copper ore; 2,719 tons, zinc ore; and 218 tons, siliceous ore. Of the total ore mined, 2,103,932 tons, with 72,392 tons of old tailings, were concentrated, producing 260,777 tons of concentrates, which contained $52,341 in gold, 6,626,395 ounces of silver, 2,715,285 pounds of copper, 230,668,285 pounds of lead, and 19,273,670 pounds of zinc (spelter), valued in all at $15,704,284, or $60.22 per ton.

The concentrates were made up of 5,482 tons of copper concentrates; 28,006 tons of zinc concentrates containing 19,273,670 pounds of spelter, as well as some gold, silver, copper, and lead; and lead concentrates from both lead ore and lead-zinc ore amounting to 227,288 tons, containing 2,437.30 ounces of gold, 6,471,709 ounces of silver, 474,949 pounds of copper, and 230,523,324 pounds of lead.

The crude ore shipped to smelters was 112,759 tons, containing $22,145 in gold, 2,710,619 ounces of silver, 2,382,609 pounds of copper, 66,072,661 pounds of lead, and 2,141,895 pounds of spelter, valued in all at $5,055,808, or $44.84 per ton. This crude ore has been separated into the various kinds with metals recovered from each. There was 80,841 tons of lead ore containing 918.32 ounces of gold, 2,552,608 ounces of silver, 215,903 pounds of copper, and 66,072,661 pounds of lead; 29,154 tons of copper ore containing 153.03 ounces of gold, 154,046 ounces of silver, and 2,165,840 pounds of copper; 2,719 tons of zinc ore, from which 2,141,895 pounds of spelter was recovered; and 45 tons of siliceous silver ore.

The placer production from 12 properties was $4,998 in gold and 46 ounces of silver.

In January, 1914, the manager [1] of the Bunker Hill & Sullivan Co. gave a good statement of conditions in this region:

> The National Mining Co. is making good progress in the erection of a most modern concentrator for the treatment of its well-developed large body of silver-bearing disseminated copper ore, and the Federal Mining & Smelting Co. is preparing machinery to treat the zinc-lead-silver ore from the old Frisco mine, so the year closes with the greatest well directed activity all over the district.
>
> Better organized and more diligent metallurgical work is being done by the larger mining companies than heretofore. The special problems in addition to the general all-around better extraction always sought are: Recovery of zinc and its separation from lead and iron materials; recovery of slimed galena from vanner and other fine tailings; raising average grade of shipping product with lowered tailings; and at the copper mines the making of low tailings and clean concentrate from the fine mineral scattered thoroughly through the hard quartzite vein rock. The unequaled advantages of abundant water, accessibility, climate, and cheap power, are now supplemented by metallurgists from the foremost colleges and best known plants who are applying to these local conditions the various devices and processes proven elsewhere, and modifying them and developing others to meet the problems here.

[1] Easton, S. A., The Cœur d'Alenes during 1913: Eng. and Min. Jour., Jan. 10, 1914, p. 68.

Mining litigation because of apex rights was confined to the Wardner or Yreka district, the pending case, the Bunker Hill & Sullivan *v.* Caledonia Mining Co., having just been dismissed, the former company granting concessions to the latter and receiving a portion of its stock, on a basis advantageous to both. Stewart Mining Co. *v.* Ontario Mining Co. was tried before district Judge Woods during January. Many of the best-known geologists and engineers appeared for either side. The plaintiff claimed apex rights based upon an edge of the vein against a fault of unknown but admitted great throw. Defendant asserted the edge was not an upper terminal edge constituting a legal apex to the vein, but was a side, or even undercut, edge, and thus no apex. Judge Woods held for the defendant and was sustained by the supreme court; an appeal has been taken to the Supreme Court of the United States.

The particularly satisfactory feature of the present state of the industry is the good low-level development in the old mines, notably in the Green Hill Cleveland on the famous Standard-Mammoth oreshoot; the Hercules has a fine ore body on its lowest level, as have also the Hecla and Bunker Hill and Sullivan.

Total quantity of ore sold or treated in the Coeur d'Alene region, Shoshone County, Idaho, 1884–1913, number of producers, and content and total value of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Tons.*	*Pounds.*	
1884 [a]	.....	.....	$258,375	.....	.....	.....	.....	$258,375
1885 [a]	.....	.....	376,607	.....	.....	.....	.....	376,607
1886 [a]	.....	.....	182,371	116,246	.....	1,500	.....	436,335
1887 [a]	.....	.....	152,276	340,000	.....	5,980	.....	1,022,996
1888 [a]	.....	.....	211,867	554,000	.....	8,000	.....	1,438,227
1889 [a]	.....	.....	174,310	1,095,265	.....	17,500	.....	2,532,978
1890 [a]	.....	.....	165,360	1,499,663	.....	27,500	.....	4,132,506
1891 [a]	.....	.....	206,700	1,825,765	.....	33,000	.....	4,868,356
1892 [a]	.....	.....	227,370	1,195,904	.....	27,839	.....	3,538,684
1893 [a]	.....	.....	304,841	1,963,561	.....	29,563	.....	4,258,621
1894 [a]	.....	.....	362,365	2,343,314	.....	30,000	.....	3,816,026
1895 [a]	.....	.....	381,134	2,471,300	.....	31,000	.....	4,016,049
1896 [a]	.....	.....	359,017	3,163,657	.....	37,250	.....	4,703,971
1897 [a]	.....	.....	339,070	3,756,212	.....	57,777	.....	6,764,010
1898 [a]	.....	.....	268,937	3,521,982	.....	56,339	.....	6,565,287
1899 [a]	.....	.....	177,803	2,737,218	.....	50,006	.....	6,263,404
1900 [a]	.....	.....	118,935	5,261,417	.....	81,535	.....	10,588,707
1901 [a]	.....	.....	101,593	4,339,296	.....	68,953	.....	8,731,662
1902 [a]	.....	.....	98,410	5,033,928	.....	74,739	.....	8,847,552
1903 [a]	.....	.....	158,146	5,471,620	.....	103,691	.....	11,885,078
1904 [b]	27	1,410,245	46,015	6,143,001	1,424,400	112,584	.....	13,592,014
1905 [b]	37	1,526,927	38,987	7,292,986	5,225,606	126,928	144,000	17,198,856
1906 [b]	36	1,622,975	86,607	7,944,338	6,393,940	126,011	2,054,998	21,133,963
1907 [b]	33	1,541,670	81,696	7,266,862	7,199,648	114,721	6,948,655	18,888,203
1908 [b]	43	1,551,680	80,167	6,364,552	9,042,876	102,069	.....	13,220,853
1909 [b]	41	1,569,332	89,418	6,201,157	8,906,944	106,779	1,280,000	13,724,065
1910 [b]	39	1,639,781	65,076	6,703,080	6,018,688	109,879	5,526,717	14,416,910
1911 [b]	50	2,004,487	86,035	7,383,899	2,926,551	127,419	8,310,435	16,306,680
1912 [b]	52	2,108,037	84,430	7,558,314	4,386,403	132,276	13,800,181	18,313,604
1913 [b]	48	2,289,226	81,749	9,337,109	5,097,894	148,370	21,415,565	20,767,410
Total..	.....	.....	5,365,667	118,885,646	56,622,950	1,949,208	59,480,551	262,607,989

[a] Ransome, F. L., Geology and ore deposits of the Cœur d'Alene district, Idaho: U. S. Geol. Survey Prof. Paper 62, p. 82, 1908.
[b] Mines reports: U. S. Geol. Survey Mineral Resources, 1904–1913.

Since mining was begun in 1884 in the Coeur d'Alene region, metals valued at $262,607,989 have been produced. Lead represents $171,932,518; silver, $73,110,347; copper, $8,662,894; gold, $5,365,667; and zinc (spelter), $3,536,563.

Beaver district.—The output of the Beaver district from 3 deep mines and 5 placers was 43,979 tons; $1,592 in gold, 37,303 ounces of silver; 127 pounds of copper, 1,670,817 pounds of lead, and 5,366,682 pounds of zinc (spelter), valued in all at $398,192. Placer production, which has been decreasing, was only $1,572 in gold and

17 ounces of silver, principally from the Black Hill claim. The Consolidated Interstate Callahan Mining Co., whose property is partly in the Placer Center district, was the main producer. According to the statement to the assessor, there were 43,663 tons of ore extracted, having a gross value of $264,644; cost of extraction was $171,607; freight and treatment, $97,262; betterments and repairs, $67,799; a net loss of $72,024. The last item is called a loss, but it simply shows that much work was done in development and mill building. The new 300-ton concentration plant at Sunset Peak was put in operation May 1, 1913. An aerial tram brings the ore from the mine, and electric haulage has been used in the mine since October. The products are first-class zinc ore and lead ore, as well as zinc concentrate and lead concentrate. In August 1,066 tons of material was shipped and this tonnage was greatly increased later. The Idora Hill Mining Co. had only a slight production, but the new mill was built, tramway erected, and electric power installed. The concentration plant has a capacity of 100 tons, with crusher, two rolls, Huntington mill, and four James tables. At the Sunset property in the same district development by a 400-foot shaft indicates that another lead and zinc producer will be added to the list.

Cœur d'Alene district.—The Silver City placer, on Prichard Creek, was slightly productive, and the Friday claim produced some con centrating ore containing scheelite and gold-bearing pyrite,

Eagle district.—The Dunlap & Smith placer was operated for five months by sluicing.

Evolution district.—Four deep mines produced 600 tons of ore, $145 in gold, 69,614 ounces of silver, 11,942 pounds of copper, and 163,953 pounds of lead, valued in all at $51,257, against $14,850 in 1912. Ore came from the H. E. M., Charles Dickens, and Nellie, but the only important output was a lead ore from the Yankee Boy mine which has exceptionally high silver content.

Hunter district.—The output of the district from 4 deep mines was 610,183 tons of ore, $21,571 in gold, 789,246 ounces of silver, 4,541,044 pounds of copper, 48,980,606 pounds of lead, and 5,683,931 pounds of zinc (spelter), valued in all at $3,988,126, or $6.54 per ton. There were 554,720 tons of ore milled, making 55,048 tons of concentrates, and 55,463 tons were shipped crude. In 1912 the same number of mines produced 585,611 tons of ore valued at $4,023,427. There was a decrease in output of all metals but copper and zinc. The Morning mine of the Federal Mining & Smelting Co. was operated the entire year, and an average of 1,000 tons of ore were milled per day, aside from much first-class lead ore shipped. The product was largely lead concentrate, but there was a greatly increased tonnage of zinc concentrate saved through the MacQuisten tube flotation process.[1] The county assessor's figures give a gross output extracted of 387,932 tons, which had a gross value of $2,021,395. The cost of extraction was $858,240; freight and treatment, $848,274; betterments and repairs, $9,722; net profit, $305,157. The Federal Mining & Smelting Co. controls this and other mines in Shoshone County. The following extracts are taken from the company report:[2]

The operating profit for the year for all property amounted to $559,510.84 and miscellaneous earnings to $567,463.40, a total of $1,126,974.24. * * * A considerable

[1] Hofstrand, O. B., Am. Inst. Min. Eng. Trans., 73, 1913.
[2] Report for Federal Mining & Smelting Co. for fiscal year ending Aug. 31, 1913.

decrease in operating profit and tonnages, with a corresponding increase in miscellaneous earnings, will be noted; this is on account of ore extraction at the Mace mines of this company having ceased in October, 1912, the ore bodies within its lines being practically exhausted. The Green Hill-Cleveland Mining Co., in which Federal owns 50 per cent of the stock, then leased the entire Mace plant. Green Hill dividends received by Federal are included in miscellaneous earnings. * * *

There were mined at all of the properties 691,487 tons (wet weight) of ore, of which 30,726 were first-class. There were milled 637,900 tons (dry weight) of ore, an average of 53,158 tons per month. There were produced during the year 84,533 tons of lead concentrates and shipping ore, averaging 43.4 per cent of lead and 15.9 ounces of silver per ton, and 6,494 tons of zinc shipping ore and concentrates averaging 45.9 per cent zinc. Of this total, 30,726 tons were first class, or shipping ore, which carried from 25.5 per cent to 62.3 per cent lead, and averaged 33.7 per cent. The first class shipped from Wardner averaged 49 per cent, from Mace 46.9 per cent lead, and from Morning 29 per cent lead. The ratio of silver contents to the lead in ore mined at Wardner was about the same as last year. The ratio of silver to lead in concentrates showed about 9 per cent increase. At Morning there was very little change in the ratio of silver contents of ore mined, the ratio decreasing in concentrates from 0.316 to 0.30 ounce to the unit, or about 5 per cent. * * * The prices received for silver produced during the last fiscal year averaged 2.67 cents higher than received during the previous year, while the average price received for lead was 11 cents per hundred pounds higher. * * *

The development work for the year at the producing mines amounted to 16,224 feet, as against 18,947 feet last year, of drifting, raising, sinking, and cross-cutting, as follows:

	Feet.
Wardner	7,197
Mace	788
Morning	5,508
Green Hill-Cleveland	2,731

At Mace the mine was shut down from July 27 to August 9 to rebuild the hoist. Extensive repairs to the Mace mine became necessary in October, 1912, as much of the timbering was more than 12 years old. From October 20 to November 1 extra timber crews were employed day and night in retimbering the shaft, skip pocket, underground levels, and repairing tracks, etc. Since these repairs were completed the main snaft has given no further trouble. * * * January 5, 1913, the Frisco mine and plant was turned over to the mechanical department to make preparations for dewatering the mine.

Between January 5 and March 17 extensive repairs were made on the boiler plant, compressors, pipe lines, and main hoist. The hoist engine station was retimbered; the shaft retimbered to the water level; and the gallows frame reconstructed and new hoist cables installed. Unwatering started March 17 with baling tanks and sinking pumps, and was completed on July 17, as to the Frisco. Unwatering of the old Gem shaft adjoining took some further time. * * *

At the Morning mill considerable experimental work was done during the year, and the changes in the grinding equipment, which were referred to in last year's report, were completed. The fine grinding is now all done by six 8-foot Hardinge conical mills and one 7 by 12 foot P. & M. tube mill, all using pebbles. These mills are equipped with the necessary dewatering feeders and settling tanks and have a total capacity of between 450 and 500 tons. * * *

A zinc flotation plant, using turpentine as a flotation medium, was installed for experimental purposes and proved so successful that it has been continued as part of the regular equipment.

An acid flotation plant for the recovery of zinc, of 50 tons daily capacity, is now almost completed and is expected to accomplish good results as indicated by preliminary laboratory experiments. This plant operates on the same principle as those now in operation at the Green Hill and Hercules mills. It should be in operation about September 15 and will handle some of the vanner tails, which are now rejected without further treatment. * * *

As foreshadowed in my last report, the option on seven-tenths of the Cleveland group of the Idaho Investment Co. was taken up at the time specified. Negotiations were then begun for the acquisition of the Green Hill ground and the remaining three-tenths interest in the Cleveland group. These negotiations were successfully terminated in the organization of the consolidated Green Hill-Cleveland Mining Co., to which company Federal deeded its seven-tenths interest in the Cleveland group and the owners thereof deeded their three-tenths interest in the Cleveland group

and also all of the Green Hill ground. Subsequently, Federal leased to the Green Hill-Cleveland Mining Co. all of the mining and milling plant of the Mace mines for an indefinite term, until the ores in the ground belonging to the new company are exhausted, receiving therefor a rental of $180,000, payable out of the first profits of the new company, before any dividends were declared. Federal also sold to the new company all operating materials and supplies on hand, which were also paid for before dividing profits. Ownership of the Green Hill Co. lies 50 per cent with the Federal Co. and 50 per cent with the Green Hill interests. * * *

The Helena-Frisco property was purchased in January, 1913, for $100,000. This company agrees to spend $150,000 in dewatering the mine and equipping it for further active work. * * *

In January, 1913, an agreement was entered into with the Star Mining Co. and certain of its stockholders, whereby Federal has acquired an option on 96 per cent of the stock. * * *

In December, 1912, an agreement was entered into whereby Federal obtained an option on 510,000 shares of stock of the Flynn Group Mining Co., being 51 per cent thereof.

The Gold Hunter mine was operated the entire year, and the mill treated 400 tons per day, making a slightly increased output. The greater part of the material shipped is a lead concentrate. A crude lead ore is picked from the sorting belt, but no zinc product is made. As in former years, the mine was operated at a loss. The statement to the assessor gives 114,000 tons of ore extracted, having a gross value of $489,148. Costs were as follows: Extraction, $280,000; freight and treatment, $168,000; betterments and repairs, $43,635; net loss, $2,487.

The Snow Storm mine and concentration mill were operated the entire year, producing more copper than any other mine in the State. According to the statement to the assessor, there were 105,674 tons of ore extracted, having a gross value of $709,577; cost of extraction was $309,161; freight and treatment, $207,847; betterments and repairs, $55,112; net profit, $137,455. Dividends paid in 1913 amounted to $112,461. Nearly 30 per cent of this ore was shipped for converter lining and the rest was concentrated in the 250-ton mill at Larson. In the printed report for the year ending June, 1913, the tonnage of ore mined was given as 99,545 tons. About half of this, assaying 2.75 per cent copper and 4.23 ounces of silver, was milled, and the remainder, assaying 3.31 per cent copper and 5.78 ounces of silver, was shipped. The copper output was 4,522,605 pounds and the silver 368,906 ounces. The cost of copper per pound was 10.735 cents, and the mill was handling 7,000 tons per month. Detailed costs were recently published.[1]

The Alice Mining Co. was operated periodically during the year, largely through lessees. The mill has a capacity of 125 tons. According to the statement given to the county assessor the Alice Mining Co. produced 319 tons of concentrates, having a gross value of $14,912. The cost of extraction was $13,718; freight and treatment, $4,868; net loss, $3,674.

The National Mining Co. with property 1 mile west of the Snow Storm, though not shipping in 1913, did much work in opening ore and preparing to construct a 500-ton plant designed to use concentration and flotation. The plant will consist of crusher, rolls, 6 Hardinge mills, 10 Wilfley tables, and 10 Deister tables. Through a long tunnel the lode was cut at a depth of 1,700 feet and was said to be 70 feet wide and 350 feet long. The ore is low-grade copper,

[1] Min. and Sci. Press, Jan. 24, 1914, p. 185.

similar to that of the Snow Storm. The district around Mullan is treated in a recent report [1] of the Survey.

Lelande district.—Six deep mines produced 445,379 tons of ore, $23,728 in gold, 4,112,649 ounces of silver, 291,394 pounds of copper, 94,428,022 pounds of lead, and 998,426 pounds of zinc (spelter), valued in all at $6,763,678, or $15.19 per ton. In 1912 the district output had a value of $5,490,935 from 501,951 tons of ore. Most of the ore, or 408,787 tons, was concentrated (59,913 tons of concentrates), and 36,592 tons was shipped directly to smelters. The Hercules mine at Burke was the largest producer, and in profits even surpassed the Bunker Hill & Sullivan property at Wardner. The statement given to the assessor for the Hercules mine shows an output of 40,816 tons of ore and concentrates, having a gross value of $2,846,758. Costs were as follows: Extraction, $669,002; freight and treatment, $791,135; betterments and repairs, $179,304; net profit, $1,207,326. Dividends are not published, but were estimated [2] to be $1,500,000. In June there was a big cave-in at this mine resulting from floods, which caused a shutdown and interrupted production for two months, but in August a total of 3,807 tons of crude ore and concentrates were shipped. The mill at Wallace is one of the best planned and equipped concentration plants in the Coeur d'Alene region. Much of the machinery was designed by Franz Bros., who are responsible for the construction and operation of the plant, which includes crushers, rolls, Hartz & Hancock jigs, Huntington mills, Franz tables, and Wyman acid flotation process for zinc recovery as an auxiliary. The mill was treating about 400 tons of ore a day.[3] Work on the lower or Humming Bird tunnel was in progress during the year. This will be over 8,000 feet long and will cut the lode 800 feet below the present working tunnel.

The Hecla mine at Burke was operated the entire year, shipping crude ore and concentrates from the 300-ton mill. The output was nearly the same as in 1912. The mine is opened by vertical shaft 1,600 feet deep. According to the statement given to the county assessor, the Hecla Mining Co. extracted 141,930 tons of ore, having a gross value of $1,026,754. The cost of extraction was $402,998; freight and treatment, $299,060; betterments and repairs, $32,000; net profit, $292,695. Dividends aggregated $300,000 for the year.

The Marsh mine at Burke increased its output, shipping between 200 and 300 tons of concentrate per month from the leased mill north of Wallace.

The Green Hill-Cleveland mine, controlled by the Federal Mining & Smelting Co. and worked through the Standard-Mammoth at Mace, was productive most of the year. The ore has excellent silver content even at great depth, which had a marked effect on the silver output of the State. Ore is milled at Wallace and a zinc concentrate is saved by flotation. Considerable first-class ore is also shipped. Troubles with the hoist interrupted mining part of the year. In August 2,227 tons of crude ore and concentrate were shipped. The assessor's figures follow: Ore extracted, 173,846 tons; gross value,

[1] Calkins, F. C., and Jones, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: U. S. Geol. Survey Bull. 540, pp. 167–211, 1914.
[2] Min. and Sci. Press, Jan. 24, 1914, p. 198.
[3] Min. and Eng. World, Nov. 29, 1913, p. 967.

$2,083,108; cost of extraction, $647,802; freight and treatment, $515,292; betterments and repairs, $81,862; net profit, $838,149.

In 1913 the old Frisco mine was secured by the Federal Mining & Smelting Co. and unwatered. The Frisco shaft is 1,650 feet deep and there are two adits, 1,100 feet and 1,500 feet. A 200-ton concentrator was being constructed and a zinc concentrate will be shipped. Output in 1913 was only a little lead ore taken out by lessees.

Placer Center district.—The district produced 110,914 tons of ore, $2,744 in gold, 302,426 ounces of silver, 45,628 pounds of copper, 10,885,255 pounds of lead, and 9,238,088 pounds of zinc (spelter), valued in all at $1,188,765. In 1912 the district produced 83,516 tons valued at $787,777. Most of the ore was concentrated, making lead concentrate and zinc concentrate. The Tamarack & Custer Consolidated Mining Co. was an important producer of silver-lead ore during most of the year. The output was increased from 700 tons of crude ore and concentrate in March to 1,284 tons in August.

The 150-ton mill of the Rex mine was leased, and ore goes to the plant by aerial tramway. First-class ore was hand-sorted from conveyor belt. The county assessor's figures for the property give 11,868 tons of crude ore and concentrates, which had a gross value of $532,206. The cost of extraction was $251,631; freight and treatment, $166,134; betterments and repairs, $56,751; net profit, $57,688.

Plans for future development contemplate running a long lower tunnel to tap known ore bodies at depth, doing away with aerial tramway now conveying ores from mine to mill. With construction of proposed tunnel a new 300-ton concentrator is to be built on Nine Mile, presumably on ground recently acquired by company, near Bunn station, which would deliver concentrates directly to Nine Mile branch of Northern Pacific. Erection of new mill will require acquisition of additional water rights. All contemplated improvements are to be done through revenue derived from sale of ore from mine. It was decided at annual meeting week before last to create and maintain a surplus fund of $100,000 before any developments and improvements are commenced.[1]

The Success Mining Co. operated the 250-ton concentration plant the entire year on a sulphide ore containing mostly zinc with some lead. According to the county assessor's figures, the Success mine produced 62,790 tons of ore, having a gross value of $291,056. Cost of extraction was $281,866; net profit, $9,190. Dividends were reported as $90,000. In August there were 1,421 tons of concentrates shipped, principally zinc. As this product contains much iron, a plant designed to use magnetic separation was added at the close of the year.

St. Joe district.—The output consisted of a small placer production and a shipment of copper ore from the Richmond property on the Idaho-Montana divide. Descriptions[2] of the region have been published by the Survey.

Summit district.—The district output from 7 deep mines and 1 placer was 1,214 tons of ore, $2,798 in gold, 1,544 ounces of silver, 276,872 pounds of lead, and 128,438 pounds of zinc (spelter), valued in all at $23,106. The output in 1912 was 26,115 tons of ore, and a total value of $222,750. From these figures, it will be seen that the

[1] Eng. and Min. Jour., Feb. 14, 1914, p. 396.

[2] Calkins, F. C., and Jones, E. L., jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: U. S. Geol. Survey Bull. 540, pp. 167–211, 1914. Collier, A. J., Ore deposits of the St. Joe River basin, Idaho: U. S. Geol. Survey Bull. 285, 1906. Pardee, J. T., Geology and mineralization of the upper St. Joe River basin, Idaho: U. S. Geol. Survey Bull. 470, 1911.

district was quiet in 1913. The Bear Top-Orofino, Black Horse, Monarch, and Terrible Edith were the lead and zinc producers, and a small quantity of gold ore was milled. The Terrible Edith was the main producer, both lead ore and zinc ore of good grade being shipped. The Black Horse and Monarch mills were active only a short time.

Yreka district.—Eight deep mines produced 1,076,899 tons of ore, $26,002 in gold, 3,506,819 ounces of silver, 191,045 pounds of copper, and 140,335,421 pounds of lead, valued in all at $8,348,492, or $7.75 per ton. This total value is larger than that of any other district in the State. There were notable increases in silver and lead over the output of 1912, when 7 mines produced 909,671 tons of ore, valued at $7,723,659. Most of the ore (990,594 tons) was milled together with some old tailings, making 115,307 tons of lead concentrate. The rest of the ore, 13,913 tons, was shipped without treatment.

The Bunker Hill & Sullivan Co. considerably increased its lead output in 1913. The county assessor's figures are as follows: Ore extracted, 436,060; gross yield, $3,889,767; cost of extraction, $1,213,859; cost of freight and treatment, $1,557,647; betterments and repairs, $70,004; net profit, $1,062,512. Three concentration plants were active, one of 1,100 tons, one of 800 tons, and one of 850 tons for tailings.

The result of the year's work,[1] both as to production, earnings, and new ore found, compares well with the results of past years. The development of new ore on No. Thirteen level, 800 feet vertically below the Kellogg (mill adit) tunnel, has been very successful. The continuation to this level of three important ore shoots from the No. Twelve level and their great value has been already demonstrated. The shaft is now in process of sinking to the No. Fourteen level with all conditions regular and normal.

Research and experimental work to improve our milling work was continued throughout the year, and the economic extraction shows 1.7 per cent higher than reported in the last annual report.

More of the old upper workings of the Tyler, Bunker Hill, Stemwinder, and Sullivan mines were thrown open to tributers or leasers, and as royalties from this production there was collected during 1913 the sum of $14,256.45.

The suit started by this company against the Caledonia Mining Co., noted in my last report, has been dismissed by stipulation of compromise, and we have received 1,302,500 shares of the stock of the Caledonia Mining Co., which has a capitalization divided into 2,605,000 shares. Connection is now being made from our Kellogg tunnel to the mine workings of the Caledonia Co., and early during the current year this connection will be completed and regular output and substantial earnings begun by the Caledonia Mining Co.

We have acquired altogether about 94 per cent of the stock of the Sierra Nevada Consolidated Mining Co. The old workings, being the upper portion of the property of that company, have been mined continuously under lease during 1913 and have paid during that time $14,386.81 as royalty. New ground has been systematically developed during the year and a good tonnage of fair grade ore exposed. During October, November, and December, 1913, 3,696 tons of this ore was mined and milled, and at this date the production amounts to 100 tons daily, which will be increased as conditions permit; so that the remaining debts of the Sierra Nevada Co. should be paid during the current year.

Reference was made in the last annual report to litigation with the Stewart Mining Co. The cases brought by the Stewart Mining Co. against the Bunker Hill & Sullivan Mining & Concentrating Co. and against the Sierra Nevada Consolidated Mining Co. were tried in the district court of the United States during December, 1913, and the court rendered its decision on January 16, 1914, dismissing the complaint of the Stewart Co., but it is not known whether an appeal will be taken. The same issues are now before the Supreme Court of the United States, in which the Stewart Mining Co. is appealing from the Idaho State courts in its case against the Ontario Mining Co. In due course the Stewart Mining Co. must respond with damages for the ore taken by it from beneath the Saxon claim of the Bunker Hill Co. * * * The con-

[1] Bunker Hill & Sullivan Mining & Concentrating Co. Ann. Rept. for year ending Dec. 31, 1913.

centrators were in operation for the full year. * * * During the year 436,643 tons of ore were concentrated, making the average work of the concentrators, 1,193 tons per day, or, say, 1,230 tons per 24 hours of actual operation, at a cost of $220,895.93. * * * The company shipped 59,471.11 tons of concentrates at a cost of $16,386. * * * The mine product was 436,822 tons of ore assaying 10.15 per cent lead and 3.97 ounces of silver. There were 179 tons of shipping ore assaying 50.34 per cent lead and 20.77 ounces of silver, and 58,408 tons of concentrates assaying 60.72 per cent lead nd 20.70 ounces of silver. * * * From May, 1886, to January, 1914, the property produced 6,021,548 tons of ore, having a total gross assay value of $56,869,043, with net smelter returns of $33,810,802, operating profit $18,867,627, dividends paid, $14,729,250.

The Stewart Mining Co. was active throughout the year, shipping crude lead ore from the mine and concentrates from the 500-ton mill at Wallace. According to the statement to the assessor for the Stewart Mining Co. there were 174,126 tons of ore extracted, having a gross value of $1,629,474; cost of extraction was $488,995; freight and treatment, $524,489; betterments and repairs, $54,556; net profit, $561,432. Dividends were $402,467. In a report for the half year from January to June, 1913, the tonnage milled was 87,283 short tons; crude ore shipped, 1,963 tons, which, with concentrates shipped, yielded 657,416 ounces of silver and 13,545,300 pounds of lead.

The Last Chance mine of the Federal Mining & Smelting Co., at Wardner, was in continuous operation, milling about 700 tons of ore per day and shipping first-class ore from the sorting plant. The assessor's statement follows: Ore extracted, 265,200 tons; gross yield, $1,217,071; cost of extraction, $709,440; freight and treatment, $385,301; betterments and repairs, $949; net profit, $121,380.

Ore from the Ontario mine was treated in the 250-ton Silver King concentration mill and a first-class product was shipped without treatment. The mill has a Blake crusher, a Hardinge mill, 4 Deister slime machines, and 4 Wilfley tables. The mine is opened by the Silver King adit from Government Gulch. In August the company was shipping at the rate of 962 tons of concentrates and crude ore. According to the county assessor's figures, the mine produced 72,901 tons of ore, of which the gross yield was $592,372; cost of extraction was $226,889; freight and treatment, $181,691; net profit, $183,791.

The Sierra Nevada Consolidated Mining Co. made a production of ore which was concentrated in a leased mill. The old fillings of the mine were reworked by lease during the entire year and the new bodies worked since June, 1913. At the Hypothek property on Big Creek development was carried on and a 40-ton concentration plant was operated six weeks.

On account of law suit with the Bunker Hill Co., the Caledonia Mining Co. was not productive, except for a few cars. Difficulties have been adjusted, and the mine will be operated in 1914. The ore will go through the Kellogg tunnel of the Bunker Hill Co. and be treated in a unit of the Bunker Hill mill. In return the latter company receives part of the stock and management of the Caledonia mine. The Big Creek mine was productive of a shipment of silver chloride ore.

TWIN FALLS COUNTY.

From Snake River, near Twin Falls, $924 in gold and 2 ounces of silver were produced.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY ON METAL MINING AND MINERALS IN IDAHO.

CALKINS, F. C., and MACDONALD, D. F., A geologic reconnaissance in northern Idaho and northwestern Montana: Bull. 384, 112 pp., 1909.

CALKINS, F. C., and JONES, E. L., jr., Geology of the St. Joe-Clearwater region, Idaho: Bull. 530, p. 75, 1913.

——— Economic geology of the region around Mullan, Idaho, and Saltese, Mont.: Bull. 540, 1914.

COLLIER, A. J., Ore deposits in the St. Joe River basin, Idaho: Bull. 285, p. 129, 1905.

ELDRIDGE, G. H., A geological reconnaissance across Idaho: Sixteenth Ann. Rept., pt. 2, p. 211, 1895.

GALE, H. S., Geology of the copper deposits near Montpelier, Bear Lake County, Idaho: Bull. 430, p. 112, 1910.

HILL, J. M., Mining districts of the western United States: Bull. 507, 309 pp., 1912.

LINDGREN, WALDEMAR, The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: Twentieth Ann. Rept., pt. 3, pp. 75–256, 1900.

——— Mineral deposits of the Bitterroot Range and the Clearwater Mountains, Montana: Bull. 213, pp. 66–70, 1903.

——— A geological reconnaissance across the Bitterroot Range and Clearwater Mountains in Montana and Idaho: Prof. Paper 27, 123 pp., 1904.

——— The mining districts of Idaho Basin and the Boise Ridge, Idaho: Eighteenth Ann. Rept., pt. 3, pp. 625–736, 1898.

——— The copper deposits of the Seven Devils: Twentieth Ann. Rept., pt. 3, pp. 249–253, 1900.

——— Resources of the United States in gold, silver, copper, lead, and zinc: Bull. 394, pp. 114–156, 1909.

LINDGREN, WALDEMAR, and DRAKE, N. F., Silver City geologic folio 104, 1904.

——— Nampa geologic folio 103, 1904.

MACDONALD, D. F., Economic features of northern Idaho and northeastern Montana: Bull. 285, pp. 41–52, 1906.

PARDEE, J. T., Geology and mineralization of the upper St. Joe River basin, Idaho: Bull. 470, 1911.

RANSOME, F. L., and CALKINS, F. C., Geology and ore deposits of the Coeur d'Alene district, Idaho: Prof. Paper 62, 203 pp., 1908.

RICHARDS, R. W., Notes on lead and copper deposits in the Bear River Range, Idaho and Utah: Bull. 470, pp. 177–187, 1911.

RICHARDS, R. W., and MANSFIELD, G. R., Geology of the phosphate deposits northeast of Georgetown, Idaho: Bull. 577, 1914.

RUSSELL, I. C., Geology and water resources of the Snake River plains in Idaho: Bull. 199, 1902.

——— Notes on the geology of southwestern Idaho and southeastern Oregon: Bull. 217, 1903.

——— Geology and water resources of Nez Perce County, Idaho: Water Supply Papers 53 and 54, 1901.

SANFORD, SAMUEL, and STONE, R. W., Useful minerals of the United States: Bull. 585, p. 63, 1914.

SCHULTZ, A. R., and RICHARDS, R. W., A geologic reconnaissance in southeastern Idaho: Bull. 530, p. 267, 1911.

UMPLEBY, J. B., Lead-silver deposits of the Dome district: Bull. 540, 1914.

——— Geology and ore deposits of Lemhi County: Bull. 528, 1913.

——— A preliminary account of the ore deposits of the Loon Creek district, Idaho: Bull. 530, p. 66, 1911.

——— Some ore deposits in northwestern Custer County, Idaho: Bull. 539, 1913.

WEED, W. H., The copper production of the United States: Bull. 260, pp. 211–216, 1905.

——— The copper mines of the United States in 1905: Bull. 285, pp. 93–124, 1906.

WEEKS, F. B., and HEIKES, V. C., Notes on the Fort Hall mining district, Idaho: Bull. 340, pp. 175–183, 1908.

GOLD, SILVER, COPPER, AND LEAD IN WASHINGTON IN 1913.

(MINES REPORT.)

By C. N. Gerry.

PRODUCTION.

The value of the mine production of gold, silver, copper, and lead in Washington in 1913 was $1,053,135, a slight decrease of $67,079. Increases were made in gold, in lead, and in the tonnage of ore shipped or treated; but small decreases occurred in silver and in copper, principally in Stevens County. There were 57 producing mines in 1913, against 46 in 1912.

The output of the State in 1912 and 1913 is shown in the following table:

Mine production of gold, silver, copper, and lead in Washington in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	46	94,981	$680,964	413,538	1,086,010	127,387	$1,120,214
1913	57	115,685	696,275	331,239	954,081	202,487	1,053,135
Increase (+) or decrease (−) in 1913		+ 20,704	+ 15,311	− 82,299	−131,929	+ 75,100	− 67,079

[a] Includes a small placer production.

An effort has been made to get the approximate metal output of Washington from the date of earliest production to the present time. For the last ten years the figures are accurate, both for State and county totals, but for many of the early years the totals are largely those of the Mint and lack detailed information regarding districts or counties. It will be seen that Washington has produced in the past gold, silver, copper, lead, and zinc, valued at more than $30,000,000, of which gold represented 83 per cent, silver 13 per cent, and copper and lead about 2 per cent each. The Territory of Idaho was formed in 1863. Production prior to 1866 includes some gold from localities that afterward became Idaho.

Quantity of ore sold or treated in Washington, 1860–1913, number of mines producing, and total output of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
Prior to 1866 [a]			$9,000,000	120,500			$9,161,108
1866 [a]			1,000,000	12,500			1,016,737
1867 [b]			400,000	5,000			406,650
1868 [b]			400,000	5,000			406,630
1869 [c]			300,000	3,750			304,969
1870 [c]			300,000	3,750			304,980
1871 [c]			320,107	4,000			325,407
1872 [c]			260,000	3,250			264,297
1873 [c]			206,341	2,355			209,395
1874 [c]			154,535	1,925			156,995
1875 [c]			81,932	1,000			83,172
1876 [d]			26,988	320			27,359
1877 [d]			300,000	41,667			350,000
1878 [d]			300,000	21,739			325,000
1879 [d]			75,000	17,857			95,000
1880 [e]			135,800	886			136,819
1881 [f]			120,000	1,450			121,639
1882 [f]			120,000	1,450			121,653
1883 [f]			80,000	387			80,430
1884 [f]			73,952	912			74,964
1885 [f]			126,172	52,208			182,035
1886 [f]			147,548	123,752			270,062
1887 [f]			160,503	94,516			253,129
1888 [f]			145,000	123,750			261,325
1889 [f]			193,709	81,984			270,774
1890 [f]			204,000	69,628			277,109
1891 [f]			371,897	165,883			536,121
1892 [f]			373,553	151,554			505,405
1893 [f]			228,394	134,961			333,664
1894 [f]			232,761	9,683			238,861
1895 [f]			373,148	109,060			444,037
1896 [f]			395,490	233,407			554,207
1897 [f]			449,664	242,780			595,332
1898 [f]			612,118	329,549		857,555	838,968
1899 [f]			729,388	289,661	76,410	1,032,069	962,774
1900 [f]			732,437	302,570	36,831	1,091,945	973,711
1901 [f]			661,240	377,381	29,520	216,841	901,823
1902 [f]			374,471	721,450	40,426	242,516	771,408
1903 [f]			446,364	305,401	91,441	215,134	632,498
1904 [g]	54	59,310	314,463	157,598	350,047	1,760,309	518,019
1905 [g]	51	46,650	405,078	125,376	108,709	605,043	526,200
1906 [g]	52	27,133	221,648	45,878	235,030	926,100	350,533
1907 [g]	53	44,413	269,074	55,359	297,812	820,035	398,635
1908 [g]	64	37,633	242,234	88,823	312,030	1,150,429	378,816
1909 [g]	46	36,308	362,051	79,488	255,134	288,700	448,966
1910 [g]	76	59,209	788,145	205,345	86,918	1,322,287	968,249
1911 [g]	60	82,305	847,677	243,781	318,207	848,584	[h]1,056,017
1912 [g]	46	94,981	680,964	413,538	1,086,010	127,387	1,120,214
1913 [g]	57	115,685	696,275	331,239	954,081	202,487	1,053,135
Total			25,430,121	5,915,301	4,278,606	11,707,421	30,595,231

[a] Browne, J. R., Mineral Resources of the States and Territories west of the Rocky Mountains, 1868 (with estimate of silver).
[b] Estimated by C. N. Gerry.
[c] Raymond, R. W., Statistics of mines and mining in the States and Territories west of the Rocky Mountains, 1870–1876.
[d] Director of the Mint, Ann. Repts., 1876–1879.
[e] Emmons, S. F., U. S. Geol. Survey Mineral Resources, p. 85, 1892.
[f] Director of the Mint, Ann. Repts., 1881–1903.
[g] Mines Repts.: U. S. Geol. Survey Mineral Resources, 1904–1913.
[h] Also includes value of 20,590 pounds of spelter.

ORE PRODUCTION IN 1913.

The ore sold or treated increased from 94,981 short tons in 1912 to 115,685 tons in 1913, an increase of 20,704 tons, mainly from Ferry County, but in part from Stevens County. The total value of the ore per ton decreased from $11.74 in 1912 to $9.07 in 1913, and the value per ton in gold and silver decreased from $9.80 in 1912 to

$7.71 in 1913. This decrease was noticeable in both Ferry and Stevens counties. Most of the ore (85 per cent) was dry or siliceous in character and averaged $8.15 per ton in gold and silver. This tonnage, however, was made up of 42,175 tons of iron ore, principally sulphide, used as a flux, and 56,132 tons of siliceous ore. The iron ore averaged per ton 0.03 ounce of gold, 0.10 ounce of silver, and 3.61 pounds of copper; and the siliceous ore averaged 0.57 ounce of gold, 3.25 ounces of silver, with a trace of copper and lead. Of the latter ore, 120 tons was a silver ore; 4 tons, gold and silver ore; and the remainder, or greater part, was gold ore, in which the gold value was six times that of the silver value. The copper ore represented 14.46 per cent of the total tonnage and averaged 0.009 ounce of gold and 8.38 ounces of silver per ton, and 2.39 per cent copper. Part of this ore was concentrated. Lead ore represented only 0.56 per cent of the total and had an average assay of 0.002 ounce of gold and 6.6 ounces of silver per ton, and 15.62 per cent lead, with a trace of copper. No zinc ore was milled or shipped in 1913.

Output of ore and production of metals in Washington in 1913, by kinds of ore.

Source of production.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Placers	12		200.47	69		
Dry or siliceous ore	33	98,307	33,323.21	186,696	153,633	1,144
Copper ore	5	16,733	158.48	140,214	800,374	
Lead ore	7	645	.14	4,260	74	201,343
Total		115,685	33,682.30	331,239	954,081	202,487

Subdivision of tonnage, by kinds, of ore sold or treated from Washington in 1913, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Chelan	270			270
Ferry	67,419	379		67,798
King	155			155
Kittitas	88			88
Okanogan	511		18	529
Snohomish	215			215
Stevens	29,169	16,354	627	46,150
Whatcom	480			480
Total	98,307	16,733	645	115,685
Average value per ton in gold and silver	$8.15	$5.26	$3.99	$7.71

There were 14 milling plants of various kinds in operation in the State during 1913. Most of these were run for short periods, although the San Poil and United Copper plants were active the greater part of the year. Seven mills used amalgamation, 3 used concentration alone, 2 used cyanidation, and 2 used amalgamation and concentration. The principal mills, including the new plants, are mentioned in their respective districts and a complete list was published in the report on Washington for 1911.

Ore treated at gold and silver mills amounted to 21,658 tons in 1913, against 21,312 tons in 1912. Of the total, 20,410 tons was treated by cyanide mills and the remainder by amalgamation. There was a decrease in the latter output and a corresponding increase in the former, but not so large an increase as was expected, since the North Washington mill at Republic was only operated part of January.

Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Washington in 1913, by counties.

County.	Quantity of ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Chelan	270	331.17	160	.....	.....	$6,943
Ferry	20,410	.....	.....	6,726.17	25,589	154,498
Kittitas	88	77.15	25	.....	.....	1,610
Okanogan	410	57.54	38	.....	.....	1,212
Whatcom	480	260.88	95	.....	.....	5,450
Total	21,658	726.74	318	6,726.17	25,589	169,713

A considerable increase was made in concentrates produced, from 584 tons in 1912 to 1,130 tons in 1913. Three concentrating plants treated 10,793 tons of ore, and the plant at the United Copper mine was not run at full capacity because various improvements were being made during the year. Copper concentrates had an average assay of 0.02 ounce of gold, 36.36 ounces of silver, 9.46 per cent copper, and were valued at $51.76 per ton.

Mine production of gold, silver, copper, and lead from Washington concentrates in 1913.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.					Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
Okanogan	10	22	50.00	1,216	928	.....	$1,912
Stevens	10,783	1,108	25.23	40,092	208,322	8,254	57,390
Total	10,793	1,130	75.23	41,308	209,250	8,254	59,302

By kinds of concentrates.

Siliceous	22	50.00	1,216	928	.....	$1,912
Copper	1,101	25.23	40,034	208,322	.....	56,992
Lead	7	.....	58	.....	8,254	398

Of the ore mined, nearly 72 per cent, or 83,234 tons, was shipped to smelters. The largest part, or 92 per cent, of this shipping ore was siliceous; about 7 per cent was copper ore; and less than 1 per cent was lead ore. The siliceous ore in the classification below includes

42,175 tons of iron ore previously mentioned and 34,464 tons of ore which averaged 0.71 ounce of gold and 4.50 ounces of silver, and was valued at $17.43 per ton. The copper ore of shipping grade was all sulphide and contained 0.02 ounce of gold, 16.76 ounces of silver, and 99.04 pounds of copper, having a value of $25.93 per ton. Lead ore of shipping grade averaged 0.002 ounce of gold, 6.81 ounces of silver, 0.11 pound of copper, and 312.95 pounds of lead. It was all sulphide and had a value of $17.90 per ton.

Mine production of gold, silver, copper, and lead from Washington crude ore shipped to smelters in 1913.

By counties.

County.	Crude ore to smelter.					Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
Ferry	47,388	24,476.14	137,007	55,544	.....	$597,328
King	155	220.98	3,038	.....	.....	6,403
Okanogan	109	22.98	15,164	142	1,639	9,729
Snohomish	215	122.97	671	.....	.....	2,947
Stevens	35,367	1,110.62	108,075	689,145	192,594	203,528
Total	83,234	25,953.69	263,955	744,831	194,233	819,935

By kinds of ore.

Dry or siliceous	76,639	25,820.28	159,573	152,705	1,144	$653,855
Copper	5,978	133.25	100,180	592,052	.....	155,032
Lead	617	.16	4,202	74	193,089	11,048

GOLD.

The production of gold was 33,682.30 fine ounces valued at $696,275, against 32,941.63 ounces valued at $680,964, in 1912, an increase of $15,311. Over 22 per cent, or 7,452.91 ounces, was contained in bullion, 77 per cent, or 25,953.69 ounces, in crude ore shipped, and 75.23 ounces in concentrates. Siliceous ore was the source of nearly all the gold, as only a little over 1 per cent came from placers, copper ore, and lead ore.

Source of gold production in Washington, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Chelan	84.37	331.17	.....	.....	415.54
Ferry	.....	31,157.45	44.86	.....	31,202.31
King	.....	220.98	.....	.....	220.98
Kittitas	100.72	77.15	.....	.....	177.87
Okanogan	6.72	130.52	.....	.....	137.24
Snohomish	3.87	122.97	.....	.....	126.84
Stevens	.....	1,022.09	113.62	0.14	1,135.85
Whatcom	4.79	260.88	.....	.....	265.67
Total	200.47	33,323.21	158.48	.14	33,682.30

SILVER.

There was a decrease in silver output from 413,538 ounces, valued at $254,326, in 1912 to 331,239 ounces, valued at $200,068, in 1913. The decrease of 82,299 ounces was mainly in Stevens County. Crude ore shipped to smelters supplied 263,955 ounces, or 79.68 per cent of the silver; bullion, 25,907 ounces, or 7.82 per cent; and concentrates 41,308 ounces, or 12.47 per cent of the total. As classified below, the siliceous ore was the source of more than 56 per cent of the silver, copper ore of more than 42 per cent, and lead ore of a little more than 1 per cent. Siliceous ore, exclusive of iron ore, had an average content of 3.25 ounces of silver a ton; copper ore, 8.38 ounces a ton; and lead ore, 6.6 ounces a ton.

Source of silver production in Washington, by kinds of ore, in 1913, by counties, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Chelan	29	160	.....	.....	189
Ferry	.....	162,494	102	.....	162,596
King	.....	3,038	.....	.....	3,038
Kittitas	36	25	.....	.....	61
Okanogan	2	16,143	.....	275	16,420
Snohomish	2	671	.....	.....	673
Stevens	.....	4,070	140,112	3,985	148,167
Whatcom	.....	95	.....	.....	95
Total	69	186,696	140,214	4,260	331,239

COPPER.

Copper production decreased from 1,086,010 pounds, valued at $179,192, in 1912, to 954,081 pounds, valued at $147,883, in 1913. The decrease of 131,929 pounds was largely in Stevens County, and was due to a smaller output in the Chewelah district. Nearly 84 per cent came from copper ore, and practically all the remainder had its source in siliceous and iron ore. Over 78 per cent came from crude ore shipped and the remainder from concentrates.

Source of copper production in Washington, by kinds of ore, in 1913, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Total.
Ferry	37,979	17,565	.....	55,544
Okanogan	996	.....	74	1,070
Stevens	114,658	782,809	.....	897,467
Total	153,633	800,374	74	954,081

LEAD.

The lead production was 202,487 pounds, valued at $8,909, in 1913, against 127,387 pounds, valued at $5,732, in 1912. The output was nearly all derived from crude ore shipped from Stevens County, and especially from the Bossburg district.

ZINC.

No zinc ore was either shipped or milled in 1913, although a plant for the treatment of lead-zinc ore was being constructed in Pend Oreille County.

MINING INDUSTRY IN WASHINGTON IN 1913.

Mining was in an encouraging condition in the Chewelah district of Stevens County, although production was slightly less in 1913 than in 1912. At the largest property much development work was done, electric power was installed after much unavoidable delay, and improvements were made at the mill. More ore was shipped to smelters and more ore was milled from the Republic district than in 1912, but the North Washington Power & Reduction Co.'s mill, which was expected to do much for the district, was idle most of the year. The production from the mines of the Republic Mines Corporation, the largest producer in the past, was far below normal, and had it not been for an unusual output from the Ben Hur mine the district would have had a considerably decreased output.

Mine production of gold, silver, copper, and lead, in Washington in 1913, by counties.

County.	Quantity of ore.	Gold.		Silver.	
		Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ounces.*		*Fine ounces.*	
Chelan	270	415.54	$8,590	189	$114
Ferry	67,798	31,202.31	645,009	162,596	98,208
King	155	220.98	4,568	3,038	1,835
Kittitas	88	177.87	3,677	61	37
Okanogan	529	137.24	2,837	16,420	9,918
Snohomish	215	126.84	2,622	673	406
Stevens	46,150	1,135.85	23,480	148,167	89,493
Whatcom	480	265.67	5,492	95	57
Total	115,685	33,682.30	696,275	331,239	200,068

County.	Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Chelan					$8,704
Ferry	55,544	$8,609			751,826
King					6,403
Kittitas					3,714
Okanogan	1,070	166	1,639	$72	12,993
Snohomish					3,028
Stevens	897,467	139,108	200,848	8,837	260,918
Whatcom					5,549
Total	954,081	147,883	202,487	8,909	1,053,135

Tonnage of ore sold or treated, number of deep mines producing, and value of ores in Washington in 1912 and 1913, by counties.

County.	Quantity of ore sold or treated.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1913	Increase (+) or decrease (−).	1912	1913	1912	1913	1912	1913
	Shorttons.							
Chelan	270	− 1,173	2	2	$24.69	$25.71	$24.69	$25.71
Ferry	67,798	+12,035	12	12	12.77	11.09	12.54	10.96
King	155	− 116	1	1	34.76	41.31	34.76	41.31
Kittitas	88	+ 55	5	7	18.88	18.30	18.88	18.30
Okanogan	529	+ 178	4	6	51.19	24.30	50.74	23.85
Snohomish	215	+ 215	.....	1	.....	13.71	.....	13.71
Stevens	46,150	+ 9,070	9	13	9.15	5.65	4.52	2.45
Whatcom	480	+ 440	1	3	5.20	11.35	5.20	11.35
Total	115,685	+20,704	34	45	11.74	9.07	9.80	7.71

[a] Value per ton, placer product excluded.

There were 12 producing placer mines, of which 3 were operated by drifting and 9 by hydraulic methods. Of the 45 deep mines, 25 produced gold and silver; 9, gold, silver, and copper; 7, silver and lead; 1, silver, copper, and lead; 1, gold, silver, copper, and lead; and 2, silver.

REVIEW BY COUNTIES.

CHELAN COUNTY.

Two deep mines and 2 placers produced 270 tons of ore, $8,590 in gold and 189 ounces of silver in 1913, against 1,443 tons of ore, $35,130 in gold and 823 ounces of silver in 1912. Not a mine in the county was a steady producer.

Blewett district.—Only $1,761 in gold and silver was produced in this region. The geology of the locality has been described by the Washington Geological Survey.[1]

Entiat district.—For a few months the Rex mill was operated by lessees, and made a small production compared with that of 1912.

FERRY COUNTY.

Total tons of ore sold or treated in Ferry County, Wash., in 1905–1913, and total content of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	4	9,540	$86,053	34,945	.....	.....	$107,160
1906	10	6,364	70,742	26,403	52	.....	88,482
1907	5	2,168	4,032	14,321	131,731	.....	39,830
1908	7	722	17,333	7,906	1,144	.....	21,674
1909	9	11,453	210,437	53,694	606	.....	238,439
1910	19	37,874	714,808	185,357	61	128	814,913
1911	13	54,535	778,526	185,239	161,158	.....	896,848
1912	12	55,763	605,698	152,336	77,968	.....	712,250
1913	12	67,798	645,009	162,596	55,544	.....	751,826
Increase (+) or decrease (−) in 1913	.....	+12,035	+39,311	+10,260	−22,424	.....	+39,576

[1] Weaver, C. E., Geology and ore deposits of Blewett mining district: Washington Geol. Survey Bull. 6, 101 pp., 1911.

With the exception of copper, the metal output increased slightly. There were the same number of producing mines as in 1912, but an increase of 12,035 tons of ore was mined. From the mines of this county came 58.6 per cent of the total ore sold or treated in 1913, 92.6 per cent of the gold, and 49 per cent of the silver, of the State. Twelve mines produced 67,798 tons, which, with the exception of 379 tons of copper ore, was all siliceous and iron ore. While the tonnage increased, the value per ton decreased from $12.77 in 1912 to $11.09 in 1913. Of the ore output, 47,388 tons were crude shipping ore, having a value of $12.61 per ton, and 2,410 tons were treated by cyanidation, giving a recovery of $7.57 per ton. The ore deposits of this county and others of northeastern Washington have been described in a bulletin recently issued by the United States Geological Survey.[1]

Belcher district.—A considerable quantity of iron ore containing gold, silver, and copper was shipped from the Belcher property to be used as a flux, as has been done in former years.

Danville district.—Copper sulphide ore was shipped from the Mineral Hill mine and the Lone Star & Washington property. In the fall of 1913 much work was done at the latter. A crushing plant was built, the compressor was overhauled, and buildings were constructed. At Boundary Falls, British Columbia, 5½ miles northwest of the mine, a concentration plant was partly constructed.

Enterprise district.—No production was reported, but a small concentration plant was secured for the Hall Creek Mining & Milling Co. at Meteor.

Republic district.—Mining at Republic was begun in 1896. From the best estimates[2] available the production from that year to the end of 1902 was 28,856 tons of ore shipped or milled, giving a recovery of $1,403,230 in gold and 398,936 ounces of silver, or a total value for seven years of $1,612,911. From 1903 to 1912 the production has been given by years in the report[3] on the district. The addition of these totals, the production for 1913 included, shows that up to December 31, 1913, the camp has produced 287,722 tons of ore, $4,878,986 in gold, 1,391,778 ounces of silver, or a product of both metals valued at $5,638,466. There was also a small output of copper and lead.

During 1913 the district had an output of 54,375 tons of ore, $636,925 in gold, 160,376 ounces of silver, and 369 pounds of copper—a total value of $733,849 and an average value per ton of $13.50. This production compares favorably with that of 1912, which was 40,775 tons of ore, $594,873 in gold, and 149,752 ounces of silver. All of the ore in 1913 was siliceous, and 33,965 tons, which was shipped crude, contained 24,085.08 ounces of gold, 134,787 ounces of silver, and 369 pounds of copper. The value of the crude ore was $579,346, or $17.01 per ton. The remainder of the ore, 20,410 tons, was milled at the cyanide plants at Republic and contained 6,726.17 ounces of gold and 25,589 ounces of silver and was valued at $7.57 per ton. Milling results at Republic hardly reached expectations, as one of the plants was idle most of the year, leaving the San Poil plant to do nearly all of the work. The mill was operated on San

[1] Bancroft, Howland, The ore deposits of northeastern Washington, with a report on the Republic mining district by Waldemar Lindgren and Howland Bancroft: U. S. Geol. Survey Bull. 550, 1914.
[2] Thompson, F. A., Ore treatment at Republic, Wash.: Am. Inst. Min. Eng. Trans., p. 673, 1912.
[3] U. S. Geol. Survey Bull. 550, p. 136, 1914.

Poil and Knob Hill ore and treated about 110 tons per day. During the year a new Taylor tube mill was added. Financial difficulties hampered production at the Surprise, Lone Pine, and Pearl mines, and lessees carried on operations part of the year. The Ben Hur became the largest shipper, and in May was said to be sending out 500 tons of ore a week. The Knob Hill Mining Co. was next with a production of milling ore and considerable high-grade shipping ore. The only dividend of the year was paid by this company. According to a report [1] to stockholders for part of the year—

the bond to former owners has been paid and the company has a deed and a treasury balance. The future policy is to develop the mine on the lower levels by a deep shaft. The ore returns during 1912 amounted to $61,958; during a little over five months of 1913 they were $69,751.

Other producers in order of output were San Poil, Old Republic, Hope, Quilp, and Phil Sheridan.

KING COUNTY.

Money Creek or Miller River district.—A siliceous ore yielding $41.31 per ton in gold and silver was shipped from the Apex mine.

KITTITAS COUNTY.

Swauk district.—Small shipments of bullion from 7 deep mines and 7 placers gave an output of 88 tons of ore, $3,677 in gold and 61 ounces of silver.

OKANOGAN COUNTY.

The output from 1 placer and 6 deep mines was 529 tons of ore, $2,837 in gold, 16,420 ounces of silver, 1,070 pounds of copper, and 1,639 pounds of lead, a total value of $12,993, compared with $18,220 in 1912. Of this ore, 410 tons went to gold and silver mills and 109 tons were shipped.

Conconnully district.—A test shipment of lead ore was made from the Lone Star mine.

Meyers Creek district.—The Molson Gold Mining Co. has a plant with 6 Nissen stamps, but only small tests were made.

Nespelem district.—A shipment of rich silver ore came from the Apache mine.

Palmer Mountain district.—From 3 mines 418 tons of ore, $1,520 in gold, 2,471 ounces of silver, and 928 pounds of copper were produced, giving a total value of $3,157. Much work was done at the Owasco property in developing ore, preparing for milling, and equipping with electric power. Tests were made in a 10-stamp amalgamation and concentration plant. At the Prize mine some silver ore was shipped and tests were made in a 10-ton concentration mill which has a crusher, rolls, and Wilfley tables. Development was carried on at the Golden Zone, and the plant of two Huntington mills was operated for 10 days.

PEND OREILLE COUNTY.

Metaline district.—No shipments were made in 1913 from the low-grade lead-zinc deposits of the Metaline region. At the Clark property a 250-ton concentration plant was under construction. This

[1] Knob Hill Mining Co., June 14, 1913: Northwest Mining and Metallurgy, May, p. 20, 1913.

plant has 2 Blake crushers, a Chilean mill, classifiers, jigs, and tables. A report [1] on the district has been recently published.

PIERCE COUNTY.

The copper-smelting plant at Tacoma, the only active smelting establishment in the State, received ores from Republic, Chewelah, and other camps. Pierce County had no producing mines.

SNOHOMISH COUNTY.

Production consisted of a small placer output at Sultan and gold ore shipped from the Monte Cristo district.

STEVENS COUNTY.

Total tons of ore sold or treated in Stevens County, Wash., 1905–1913, and total content of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1905	10	12,016	$165,863	26,195	15,449	604,843	$212,523
1906	10	12,270	77,837	6,372	72,313	926,100	148,849
1907	12	23,122	149,588	17,100	65,044	820,035	217,348
1908	15	31,863	183,893	53,296	248,432	1,146,929	293,104
1909	11	23,034	121,498	21,571	220,146	288,677	173,747
1910	12	18,473	30,182	13,281	85,063	1,321,871	106,319
1911	10	26,146	27,074	40,664	153,112	836,602	105,412
1912	9	37,080	23,823	233,535	1,007,076	127,387	339,347
1913	13	46,150	23,480	148,167	897,467	200,848	260,918
Increase (+) or decrease (−) in 1913		+9,070	−343	−85,368	−109,609	+73,461	−78,429

More ore was mined in this county in 1913 than in 1912, but there was a slight decrease in yield of gold, silver, and copper. From 13 mines 46,150 tons of ore were sold or treated against 9 mines and 37,080 tons of ore in 1912. The average value per ton decreased from $9.15 in 1912 to $5.65 in 1913, probably due to more low-grade ore being concentrated. No ore was amalgamated or cyanided, the greater part, or 35,367 tons, being shipped direct to smelters. This smelting ore was valued at $203,528, or $5.75 per ton. The remainder, 10,783 tons, was milled, making 1,108 tons of concentrates, valued at $57,390, or $51.80 per ton. Of the original tonnage 29,169 tons was either siliceous or iron ore, 16,354 tons was copper ore, and 627 tons was lead ore. Both copper and lead ores were sulphides.

Bossburg district.—Lead sulphide ore from the Young America and Bonanza mines was shipped to East Helena, Mont., and Trail, British Columbia.

Cedar Canyon district.—The Cedar Canyon and Deer Trail No. 2 produced silver ore and lead ore, which went to Tacoma.

Chewelah district.—From 16,339 tons of ore, $2,349 in gold, 140,043 ounces of silver, and 779,632 pounds of copper were produced, giving a total value of $207,778, or $12.72 per ton. In 1912 the district produced 13,443 tons of ore, $2,077 in gold, 228,747 ounces of silver, 941,833 pounds of copper, and 51,454 pounds of lead, giving a total

[1] Bancroft, Howland, Ore deposits of northeastern Washington: U. S. Geol. Survey Bull. 550, pp. 40–49, 914.

value of $300,474, or $22.35 per ton. More concentrates were made in 1913, but most of the product still comes from crude ore. The Copper King mine and the United Copper property were productive. From 1901 to and including 1913 the Chewelah district produced 42,224 tons of ore, containing $54,928 in gold, 455,230 ounces of silver, 2,181,849 pounds of copper, and 222,030 pounds of lead, a total value of $676,823. Most of this output was made in 1911, 1912, and 1913, although there was a good tonnage in 1908, when the Northport smelter was operated. From the Copper King mine, developed by two tunnels, 1,000 feet and 1,200 feet long, a low-grade copper ore was shipped. Preparations were made for the installation of an oil-fired blast furnace on this property. The main producer was the United Copper Mining Co.,[1] which was active the entire year.

In February we made a contract with the Stevens County Power & Light Co. for power to be delivered to the mine not later than the first day of July, but with full assurance on their part that power would be available much earlier than that. Owing to unavoidable and unforeseen delays * * * this power was not available on July 1, nor for three and one-half months after that, and as a great deal of construction work had been done, and general arrangements had been made for transforming our power plant from steam to electricity at any time in the month of June, you will understand that we were in no condition to crowd all our several lines of work as could have been done had no such complete change in the power plant been undertaken. * * * And when we were finally able to discontinue the use of our steam plant and connect up with the new electric line, our mill plant still had to undergo the necessary transformation, and it was nearly December before it was again in first-class running condition. * * * But, as we had always maintained it would do, the use of electric power immediately showed a substantial reduction from our former fuel bills. * * * With this electric power we have been able greatly to increase our milling capacity, the footage in the lower tunnel has been increased by at least one-third each month, and for all the stoping and development work in the most distant upper workings of the mine there has been at all hours of the 24 abundant power to work to the best advantage possible, giving at least one-third more power than the old steam plant, completely lighting the buildings of the mill and compressor plants, and all at a considerably lower cost. * * * As we have proceeded with the work of sinking the double compartment shaft and drifting on the levels below the 400-foot level we have encountered ore bodies carrying equally good values in copper, but with somewhat decreasing silver values below the showing of high-grade ore shipped during the year 1912. * * * The ore encountered on the 500 and 600 foot levels is of a good grade of shipping ore, running from $17 to $20 per ton, and with the vast tonnage that we have blocked out, the abundant power available, the increased capacity of the mill, the completion of the lower tunnel, and the installation of an adequate tramming equipment out of the lower tunnel to the mill, we will be able to mine, mill, and ship three times the amount of ore ever taken from the mine at approximately one-third the cost of operating. * * * In the latter part of November a new shoot of ore was discovered just above the 400-foot level, which is proving to be of exceptionally good values and is developing into a very large ore body. Drifts have been run over 100 feet, showing an average width of from 4 to 8 feet, with values running over $15, principally in copper. This is considered one of the most permanent ore shoots yet discovered in the mine, and gives a very large additional tonnage in ore reserves. * * * At this present date of January 28, 1914, the total footage of the lower tunnel is about 3,700 feet, with probably about 500 feet yet to run to the point decided upon from which to make connection with the double compartment shaft being sunk from above. This should be accomplished within the next 60 days.

The concentration plant[2] was said to be doubled in capacity in 1913 by the addition of four new batteries of three stamps each.

Colville district.—Only a small quantity of lead ore came from the Acorn property.

[1] United Copper Mining Co., Ann. Rept. for year ending Dec. 31, 1913.
[2] Min. and Sci. Press, July 5, 1913, p. 30.

Kettle Falls district.—One carload of ore was shipped from the Ben Venue mine.

Marcus district.—The Napoleon mine continued to produce a large tonnage of pyrrhotite, which was shipped to the British Columbia Copper Co.'s plant at Greenwood, British Columbia.

Northport district.—The only production was a small shipment of galena from the Paragon mine.

Orient district.—At the Galena Hill property a lead ore was mined and the concentration plant was reconstructed. A very good description [1] of the properties in this region was published in June, 1913.

Springdale district.—Copper ore is being developed by 2,000 feet of tunnels and drifts at the Togo property.

WHATCOM COUNTY.

In the Mount Baker district gold ore was milled from the Mount Baker and Boundary Red Mountain mines, and in the Slate Creek district from the Seattle-St. Louis property. A bulletin [2] has just been issued on the mineral resources of Washington, with a map showing the location of mines, quarries, etc., in the State.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY ON METAL MINING AND MINERALS IN WASHINGTON.

Arnold, Ralph, Gold placers of the coast of Washington: Bull. 260, 1905.
Bancroft, Howland, Lead and zinc deposits in the Metaline mining district, northeastern Washington: Bull. 470, 1911.
——— The ore deposits of northeastern Washington, with a report on the Republic mining district by Waldemar Lindgren and Howland Bancroft: Bull. 550, 1914.
Calkins, F. C., Geology and water resources of a portion of east-central Washington: Water-Supply Paper 118, 1905.
Hill, J. M., Mining districts of western United States: Bull. 507, 1912.
Russell, I. C., A geological reconnaissance in central Washington; Bull. 108, 1893.
——— A preliminary paper on the geology of the Cascade Mountains in northern Washington: Twentieth Ann. Rept., pt. 2, p. 83, 1900.
——— A reconnaissance in southeastern Washington: Water-Supply Paper 4, 1897.
Sanford, Samuel, and Stone, R. W., Useful minerals of the United States: Bull. 585, 1914.
Smith, G. O., Contributions to the geology of Washington: Geology and physiography of central Washington; and Willis, Bailey, Physiography and deformation of the Wenatchee-Chelan district, Cascade Range: Prof. Paper 19, 1903.
——— Ellensburg folio (No. 86), 1903.
——— and Calkins, F. C., A geological reconnaissance across the Cascade Range near the forty-ninth parallel: Bull. 235, 1904.
——— Geology and water resources of a portion of Yakima County, Wash.: Water-Supply Paper 55.
——— Gold mining in central Washington: Bull. 213, 1903.
——— Mount Stuart folio (No. 106), 1904.
——— and Calkins, F. C., Snoqualmie folio (No. 139), 1906.
Spurr, J. E., Ore deposits of Monte Cristo, Wash.: Twenty-second Ann. Rept., pt. 2, pp. 777–866, 1901.
Waring, G. A., Geology and water resources of a portion of south-central Washington: Water-Supply Paper 316, 1913.

[1] Armstrong, L. F., Orient mining district: Northwest Mining and Metallurgy, June, 1913, p. 23.
[2] Landes, Henry, The mineral resources of Washington, with statistics for 1912: Washington Geol. Survey Bull. 11, 1914.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA IN 1913.

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

The ore mined in Nevada aggregated 5,367,211 tons in 1913, the recoverable metal content of which, with the placer output, was valued at $37,097,710, a decrease in value of $1,261,022, as compared with 4,763,965 tons of ore in quantity and $38,358,732 in value in 1912 from deep mines and placers. There were 786 producers, 64 of which were placers, yielding ore and bullion, as against 641 lode producers and 63 placers in 1912. The copper production contributed nearly 38 per cent of the total value, or $14,057,531, a decrease of $211,256 from that of 1912. Gold production decreased from $13,456,180 in 1912 to $11,795,130 in 1913, a difference of $1,661,050; but silver increased from $8,836,974 to $9,718,410, or $881,436. Lead decreased from $877,505 to $719,137, or $158,368; and the zinc or spelter output, although increasing in quantity, decreased in value from $919,286 to $807,502, or $111,784 in 1913. The placer production of gold increased from $231,653 to $305,442 in 1913.

Statistics showing the total recoverable metallic content since 1904, with increase and decrease for 1913, are given in the following table:

Ore sold or treated in Nevada, 1904–1913, number of producers, and total content of gold, silver, copper, lead, and zinc.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904	158	323,670	$5,060,494	4,268,123	29,317	4,229,727	.....	$7,658,216
1905	132	432,202	5,269,819	6,482,081	413,235	3,457,124	697,757	9,453,114
1906	154	496,307	10,470,704	6,770,611	1,625,985	3,823,617	2,886,328	15,714,841
1907	229	723,581	12,099,455	7,083,603	1,782,571	6,271,341	2,168,783	17,591,486
1908	421	1,425,532	11,362,941	9,508,464	15,598,788	7,245,619	1,115,851	18,818,228
1909	417	2,982,607	16,239,963	10,981,061	57,976,477	9,840,791	3,013,352	30,072,932
1910	608	3,655,775	18,878,864	12,479,871	64,359,398	4,871,130	2,707,071	34,152,148
1911	661	4,132,721	18,193,397	13,184,601	67,377,518	3,263,657	3,548,032	33,952,529
1912	704	4,763,965	13,456,180	14,369,063	86,477,494	19,500,100	13,322,988	38,358,732
1913	786	5,367,211	11,795,130	16,090,083	90,693,751	16,344,023	14,419,671	37,097,710
Increase (+) or decrease (−) in 1913		+603,246	−1,661,050	+1,721,020	+4,216,257	−3,156,077	+1,096,683	−1,261,022

[a] Includes placer production.

ORE PRODUCTION IN 1913.

From the mines of Nevada 5,367,211 tons of ore were produced, an increase of 603,246 tons when compared with the production of 1912. The average total recoverable value per ton was $6.85 in 1913, against $8 in 1912, and the gold and silver value per ton declined from $4.63 to $3.95. The largest increase in ore production was made in White Pine and Nye Counties. The output of dry or siliceous ores increased from 1,400,728 tons in 1912 to 1,616,826 tons in 1913. Under this classification is included 772,749 tons of low-grade siliceous gold ores, averaging per ton $9.06 in gold and 0.54 ounce of silver. Gold and silver mixed ores, dry or siliceous in character, aggregated 72,909 tons and averaged $7.69 in gold, 7.89 ounces of silver, and a trace of copper and lead. The siliceous silver ores, in 1913, aggregated 697,775 tons, mined by 148 producers, averaging per ton $4.29 in gold, 20.10 ounces of silver, and a trace of copper and lead, as against 476,725 tons produced by 36 producers, whose ore, in 1912, averaged $4.64 in gold and 21.37 ounces of silver. There were also produced 73,393 tons of oxidized iron-manganese ore containing lead and small values in gold and silver, which was particularly valuable to the smelters as flux.

The copper ore mined by 116 producers aggregated 3,698,255 tons, and contained 39,109.98 ounces of gold, 241,756 ounces of silver, 90,117,754 pounds of copper, and averaged $4.04 per ton in value. The output of lead ores of smelting grade decreased from 17,650 tons in 1912 to 8,573 tons in 1913. In this kind of ore smelted, the oxidized ore, largely carbonates and some oxidized ores, predominated and decreased in quantity in 1913, aggregating 6,452 tons, which averaged per ton $3.71 in gold, 20.82 ounces of silver, 11.8 pounds of copper, 416.8 pounds of lead, and in total value of $36.47 per ton. The sulphide ores of lead aggregated 2,121 tons, and averaged per ton $5.55 in gold, 24 ounces of silver, 10.6 pounds of copper, 487.2 pounds of lead, and a total value of $43.13. Production of zinc ores of shipping grade increased from 7,394 tons mined in 1912 to 10,208 tons in 1913. The oxidized or carbonate zinc ores were produced in largest quantities, and aggregated 10,136 tons, from which was recovered an average of 621.2 pounds of spelter per ton. The zinc sulphide ores aggregated 72 tons, yielding $1.44 in gold, 11.36 ounces of silver, 26.6 pounds of lead, and 694 pounds of spelter per ton. Production of copper-lead ores increased from 168 tons in 1912 to 6,197 tons in 1913. The oxidized or carbonate copper-lead ores shipped directly predominated and aggregated 6,189 tons, which averaged $8.09 in gold, 16.45 ounces of silver, 67.6 pounds of copper, 248.8 pounds of lead, and a total value of $39.47 per ton. The sulphide copper-lead ores aggregated 8 tons, containing 26 ounces of silver, 61.6 pounds of copper, and 209 pounds of lead. Lead-zinc ore aggregating 16,749 tons was produced. The largest part of it was concentrated, and yielded a lead-zinc concentrate. Only 62 tons of lead-zinc ore was of shipping grade.

The output of milling ores aggregated 4,903,034 tons, of which 1,451,485 tons were treated by the amalgamation and cyanidation processes, and the remainder, 3,451,549 tons, by concentration alone. The ores and tailings treated by cyanidation—1,090,906 tons of the

former and 54,172 tons of the latter—yielded an average of $7.28 per ton in gold and 10.38 ounces of silver. The ores amalgamated, 360,579 tons, yielded bullion averaging per ton $3.68 in gold and 0.093 ounce of silver.

Output of ore and production of metals in Nevada in 1913, by kinds of ore.

Source of production.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	64	.....	14,775.75	6,363	.....	.....	.....
Dry or siliceous ore	478	1,616,826	511,402.36	15,245,541	21,400	4,390,205	.....
Copper ore	116	3,698,255	39,109.98	241,756	90,117,754	2,097	.....
Lead ore	121	18,976	2,871.40	313,779	134,905	5,278,045	.....
Zinc ore	12	10,208	5.03	4,191	806	94,940	6,348,032
Copper-lead ore	10	6,197	2,424.89	102,042	418,886	1,541,907	.....
Lead-zinc ore	2	16,749	.....	176,411	.....	5,036,829	8,071,639
Total	.....	5,367,211	570,589.41	16,090,083	90,693,751	16,344,023	14,419,671

Subdivision of tonnage of ore sold or treated in Nevada in 1913, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	83,901	.....	.....	.....	.....	.....	83,901
Clark	6,914	1,008	1,220	10,136	328	16,749	36,355
Douglas	29	15	.....	.....	.....	.....	44
Elko	3,396	820	440	.....	512	.....	5,168
Esmeralda	508,534	29,033	658	.....	16	.....	538,241
Eureka	1,555	195	1,146	.....	1	.....	2,897
Humboldt	25,310	61	214	.....	.....	.....	25,585
Lander	27,053	344	312	.....	.....	.....	27,709
Lincoln	76,437	1,838	13,019	72	5,189	.....	96,555
Lyon	3,828	206,437	24	.....	.....	.....	210,289
Mineral	19,156	10,039	131	.....	8	.....	29,334
Nye	696,721	.....	58	.....	.....	.....	696,779
Ormsby	995	46	16	.....	.....	.....	1,057
Storey	157,562	.....	.....	.....	.....	.....	157,562
Washoe	4,805	645	952	.....	.....	.....	6,402
White Pine	630	3,447,774	786	.....	143	.....	3,449,333
Total	[a] 1,616,826	3,698,255	18,976	10,208	6,197	16,749	5,367,211

[a] Includes 772,749 tons of gold ore, 72,909 tons of gold and silver ore, 697,775 tons of silver ore, and 73,393 tons of iron ore.

GOLD.

The gold production was valued at $11,795,130, a decrease of $1,661,050, compared with 1912. Esmeralda County is credited with the largest production of gold, amounting to $5,721,077, as against $7,014,559 in 1912. Nearly all of this output is the yield of the Goldfield district, but the district yield was $1,220,328 less than in 1912. The only counties making increases in gold production were Nye ($413,864), Clark ($94,350), Mineral ($58,220), Washoe ($14,946), and Lander ($10,686). There were decreases in all other counties. Placer gold was produced in Nye, Lander, and Humboldt counties in greatest quantity, but also in six other counties, and amounted in value to $305,442, against $231,653 in 1912. Milling of the ore in 1913 by amalgamation was carried on in 12 counties, and by cyanidation in 14 counties. From these two methods of treatment

$9,665,112 in gold was produced from 1,451,485 tons of ore and 54,172 tons of old tailings. The total average gold recovery from ore and tailings was $6.42 per ton. The gold extracted by amalgamation averaged $3.68 per ton of ore treated, as against $5.43 per ton treated in 1912; and by cyanidation $7.24 per ton treated, as against $9.32 in 1912. From copper, lead, lead-zinc, and iron sulphide concentrates 49,127.37 ounces of gold were produced, against 63,344.08 ounces in 1912. The largest quantity of gold (26,747.48 ounces) was contained in iron sulphide concentrates, against 41,054.43 ounces in 1912; the copper concentrates contained 22,377.89 ounces, against 22,286.92 ounces in 1912; and the lead concentrates, 2.00 ounces, against 2.73 ounces in 1912.

Source of gold production in Nevada in 1913, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.					Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	
Churchill	.....	15,630.15	.....	.....	.....	.....	15,630.15
Clark	.....	4,477.92	56.99	63.69	.....	2,371.75	6,970.35
Douglas	38.99	25.30	.....	.....	.....	.....	64.29
Elko	71.98	2,458.62	29.16	5.32	.....	6.77	2,571.85
Esmeralda	6.92	258,699.22	17,973.81	76.38	.....	.77	276,757.10
Eureka	73.10	352.02	.53	405.51	.....	.02	831.18
Humboldt	623.94	14,664.89	2.61	118.12	.....	.....	15,409.56
Lander	1,313.96	3,315.27	52.68	247.31	.....	.....	4,929.22
Lincoln	.....	1,115.65	35.85	1,882.24	5.03	44.07	3,082.84
Lyon	38.31	1,832.69	5.18	.24	.....	.....	1,876.42
Mineral	8.22	5,925.70	83.18	25.23	.....	.....	6,042.33
Nye	12,600.33	158,532.57	.....	8.13	.....	.....	171,141.03
Ormsby	.....	241.33	2.19	.68	.....	.....	244.20
Storey	.....	41,291.16	.....	.....	.....	.....	41,291.16
Washoe	.....	2,769.18	49.68	7.55	.....	.....	2,826.41
White Pine	.....	70.69	20,818.12	31.00	.....	1.51	20,921.32
Total	14,775.75	[a] 511,402.36	39,109.98	2,871.40	5.03	2,424.89	570,589.41

[a] Includes 338,770.66 ounces from gold ores, 27,115.32 ounces from gold and silver ores, 144,961.52 ounces from silver ores, and 554.86 ounces from iron ores.

SILVER.

The silver production of Nevada in 1913 was 16,090,083 ounces, valued at $9,718,410, and showed an increase of 1,721,020 ounces in quantity and of $881,436 in value. Nye County was again in the lead with 11,634,033 ounces, against 10,210,296 ounces in 1912, and Churchill County produced 1,383,257 ounces in 1913, against 1,434,068 ounces in 1912. The largest producer of silver was the Belmont mine, at Tonopah, in Nye County, followed by the Tonopah Mining Co. and the West End Consolidated. Milling plants using amalgamation and cyanidation in the extraction of the precious metals from ores produced 11,923,597 ounces of silver, of which 33,581 ounces were recovered by amalgamation and 11,890,016 ounces by cyanidation. Nye County is credited with the largest production of silver by amalgamation, 11,040 ounces, produced from Manhattan and Round Mountain districts, and also by cyanidation, 9,808,812 ounces, from ores treated principally at Tonopah district. In Churchill County

where cyanidation was used, 1,215,797 ounces of silver were recovered. Concentrates from milling plants yielded 2,135,714 ounces of silver, against 2,301,694 ounces in 1912. The dry or siliceous ores milled produced 1,865,416 ounces from concentrates in 1913, against 2,008,655 ounces in 1912. Lead concentrates contained 133,649 ounces of silver, or an average of 43.07 ounces per ton, against 11,655 ounces, or an average of 67.37 per ton, in 1912; lead-zinc concentrates contained 4.62 ounces per ton, against 11.31 ounces per ton in 1912.

Source of silver production in Nevada in 1913, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	
Churchill		1,383,257						1,383,257
Clark		4,255	2,194	10,604	3,373	2,085	176,411	198,922
Douglas	6	3	30					39
Elko	28	15,067	6,096	7,561		16,730		45,482
Esmeralda	2	70,639	106,008	11,466		246		188,361
Eureka	5	20,194	3,028	33,644		125		56,996
Humboldt	238	748,145	661	8,461				757,505
Lander	188	99,255	491	22,075				122,009
Lincoln		213,499	25,839	154,563	818	80,386		475,105
Lyon	19	7,366	204	77				7,666
Mineral	10	213,395	11,513	3,706		208		228,832
Nye	5,867	11,627,399		767				11,634,033
Ormsby		1,992	153	324				2,469
Storey		729,972						729,972
Washoe		11,718	15,319	37,682				64,719
White Pine		99,385	70,220	22,849		2,262		194,716
Total	6,363	[a] 15,245,541	241,756	313,779	4,191	102,042	176,411	16,090,083

[a] Includes 417.867 ounces from gold ores, 575,042 ounces from gold and silver ores, 14,028,625 ounces from silver ores, and 224,007 ounces from iron ores.

COPPER.

Nevada's production of copper in 1913 was 90,693,751 pounds, valued at $14,057,531; it increased 4,216,257 pounds in quantity but decreased $211,256 in value. Most of the copper is the yield of the Nevada Consolidated Mines at Ely, in White Pine County, and of the Mason Valley Mines, in the Yerington district of Lyon County. White Pine County mines yielded 71,974,116 pounds in 1913, against 67,380,536 pounds of copper in 1912; Lyon County mines, 15,106,475 pounds, against 17,057,921 pounds in 1912. Concentrates recovered at milling plants in Nevada contained 70,049,254 pounds of copper, against 64,979,228 pounds in 1912, of which copper concentrates contained 70,041,011 pounds in 1913, against 64,932,425 pounds in 1912. Lead concentrates contained 1,803 pounds of copper, against 2,090 pounds in 1912. Crude ore shipped to smelters contained 20,610,520 pounds of copper, against 21,423,801 pounds in 1912. The crude copper ores smelted contained 20,077,061 pounds, of which 14,642,901 pounds were produced from sulphide ores and 5,434,160 pounds from oxidized ores. Lead ores yielded 99,125 pounds of copper, the sulphide ores producing 22,497 pounds and oxidized ores 76,628 pounds. Copper-lead ores contained 418,886 pounds of copper, of which the

oxidized ores contained 418,394 pounds and the sulphide ores 492 pounds.

Source of copper production in Nevada in 1913, by kinds of ore, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Total.
Churchill	4,292	.....	.....	.....	.....	4,292
Clark	176	287,470	12,982	.....	51,227	351,855
Douglas	.....	1,873	.....	.....	.....	1,873
Elko	.....	148,751	10,226	.....	41,365	200,342
Esmeralda	5,416	1,264,129	18,076	.....	1,198	1,288,819
Eureka	1,247	48,039	5,852	.....	247	55,385
Humboldt	266	16,474	325	.....	.....	17,065
Lander	1,982	115,656	2,002	.....	.....	119,640
Lincoln	536	299,218	51,576	806	309,358	661,494
Lyon	1,297	15,103,971	1,207	.....	.....	15,106,475
Mineral	1,248	767,726	70	.....	492	769,536
Nye	775	.....	1,150	.....	.....	1,925
Ormsby	.....	3,694	229	.....	.....	3,923
Storey	1,870	.....	.....	.....	.....	1,870
Washoe	1,172	131,206	2,763	.....	.....	135,141
White Pine	1,123	71,929,547	28,447	.....	14,999	71,974,116
Total	[a] 21,400	90,117,754	134,905	806	418,886	90,693,751

[a] Includes 12,024 pounds from gold ores, 71 pounds from gold and silver ores, 8,656 pounds from silver ores, and 649 pounds from iron ores.

LEAD.

The lead production of Nevada in 1913 was 16,344,023 pounds, valued at $719,137, against 19,500,100 pounds, valued at $877,505, in 1912. Lincoln County mines continued to have the largest output, 7,701,311 pounds in 1913, followed by Clark County with 6,265,783 pounds, and by White Pine County with 747,331 pounds. About 40 per cent of the output of lead was derived from concentrates and 60 per cent from crude ores shipped directly to the smelters. Lead concentrates (carbonates and sulphides) from the milling plants of the State were shipped to the smelters and contained 3,412,030 pounds, against 76,295 pounds in 1912, and averaged 54.98 per cent of lead in 1913 and 22.05 per cent in 1912; lead-zinc concentrates contained 1,741,685 pounds, averaging 6.38 per cent of lead in 1913, against an average of 15.41 per cent in 1912. The total crude ore of shipping grade contained 9,757,899 pounds of lead, against 6,558,003 pounds in 1912. Oxidized lead ore predominated and yielded 2,689,201 pounds of lead, against 2,418,812 pounds in 1912. The sulphide lead ores yielded 1,033,336 pounds of lead, against 1,953,172 pounds in 1912. Zinc ores contained 94,940 pounds, nearly all of which was in oxidized ores. Copper-lead ores contained 1,541,907 pounds, of which the oxidized and carbonate ores produced 1,540,235 pounds and the sulphides 1,672 pounds. The lead-zinc ores, all sulphides, contained 14,657 pounds of lead.

Source of lead production in Nevada in 1913, by kinds of ore, by counties, in dry pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	162						162
Clark	1,468	829	1,075,031	93,027	58,599	5,036,829	6,265,783
Elko	699		167,786		193,395		361,880
Esmeralda	5,526		278,276		4,872		288,674
Eureka	18,418		479,016		670		498,104
Humboldt	204		60,868				61,072
Lander	2,782		118,684				121,466
Lincoln	4,311,419		2,150,020	1,913	1,237,959		7,701,311
Lyon			4,595				4,595
Mineral			57,960		1,672		59,632
Nye			28,563				28,563
Ormsby			3,734				3,734
Storey	4,037						4,037
Washoe		1,268	196,411				197,679
White Pine	45,490		657,101		44,740		747,331
Total	[a]4,390,205	2,097	5,278,045	94,940	1,541,907	5,036,829	16,344,023

[a] Includes 18,998 pounds from gold ores, 4,334 pounds from gold and silver ores, 22,034 pounds from silver ores, and 4,344,839 pounds from iron ores.

ZINC.

The recoverable spelter output from zinc ores mined in Nevada in 1913, is estimated at 14,419,671 pounds, valued at $807,502. This is the largest output in the history of the State, and is 1,096,683 pounds greater than the output made in 1912. Clark County is credited with the largest part of the output, or 14,369,709 pounds of spelter, from the Yellow Pine district. The remainder of the output, 49,962 pounds, was from the Pioche district, in Lincoln County. Lead-zinc concentrates aggregated 13,642 tons, which averaged 29.45 per cent of spelter. The zinc ore shipments directly to the smelters consisted of zinc carbonate and silicate and a mixed zinc-lead-silver ore. The zinc ore shipped yielded an average per ton of 31.09 per cent of spelter, and the lead-zinc ore carried an average of 29.18 per cent.

Source of zinc production in Nevada in 1913, by kinds of ore, by counties, in dry pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Clark	6,298,070	8,071,639	14,369,709
Lincoln	49,962		49,962
Total	6,348,032	8,071,639	14,419,671

MINING INDUSTRY IN NEVADA IN 1913.

Although an important increase in ore production was made and the output of silver, copper, and zinc was the largest in the history of the State, the total value decreased through the lessened output of gold and the lower price of the other metals. Of the new mining camps, Rochester, in Humboldt County, where a largely increased

production of silver ore was made by lessees working on several properties, received the greatest attention. The Rochester district is served with a narrow-gage railroad partly built in 1913 from the foothills to Oreana, a station on the Southern Pacific Railroad. In the vicinity of Pyramid Lake, in Washoe County, the deposits of copper ore were extensively developed during 1913, and a number of shipments were made by wagon to the nearest railroad points. The region has recently been opened by the building of the Fernley-Lassen Railroad.

Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Nevada in 1913, by counties.

County.	Quantity of ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Churchill	[a] 83,795	.....	.....	14,186.39	1,215,797	$1,027,600
Clark	[b] 6,866	4,020.32	2,780	113.64	244	87,283
Douglas	1	.97	.....	.....	.....	20
Elko	[c] 3,313	1,953.40	3,050	189.97	1,915	47,306
Esmeralda	505,493	19,850.76	4,943	236,044.26	45,773	5,320,452
Eureka	[d] 1,060	.....	.....	21.17	6,880	4,593
Humboldt	[e] 6,916	6,416.80	5,068	[f] 609.23	15,200	157,483
Lander	13,524	24.14	11	[g] 2,932.02	47,143	89,590
Lincoln	2,213	.....	.....	[h] 378.52	59	7,861
Lyon	3,425	1,292.48	1,214	414.35	2,560	37,562
Mineral	[i] 10,668	154.49	53	[j] 5,312.96	122,666	187,144
Nye	[k] 682,394	24,141.95	11,040	[l] 113,877.34	9,808,812	8,784,304
Ormsby	.....	.....	.....	[m] 241.34	1,992	6,192
Storey	[n] 128,629	3,666.70	4,137	[o] 28,931.99	618,876	1,050,175
Washoe	[p] 3,166	2,729.36	1,062	[q] 13.87	2,099	58,616
White Pine	22	31.38	223	.....	.....	784
Total	1,451,485	64,282.75	33,581	403,267.05	11,890,016	16,866,965

[a] Also yielded 598 tons of concentrates.
[b] 40 tons.
[c] 17 tons.
[d] 37 tons.
[e] 36 tons.
[f] Includes bullion from 1,900 tons of old tailings.
[g] Includes bullion from 12,730 tons of old tailings.
[h] Includes bullion from 10 tons of old tailings.
[i] Also yielded 7 tons of concentrates.
[j] Includes bullion from 5,437 tons of old tailings.
[k] Also yielded 3,098 tons of concentrates.
[l] Includes bullion from 8,255 tons of old tailings.
[m] Produced from 995 tons of old tailings.
[n] Also yielded 619 tons of concentrates.
[o] Includes bullion from 23,345 tons of old tailings
[p] Also yielded 1 ton of concentrates.
[q] Produced from 1,500 tons of old tailings.

Of the important milling plants operating in Nevada, the Bonnie Clare mill, 38 miles south of Goldfield, was treating ores from the Jumbo Extension mine and the Florence-Goldfield mine at Goldfield. At Virginia City, the Mexican mill turned out much bullion, not only from Mexican ore, but also from the Monte Cristo mine, which was leased. The Butters plant of the Chollar Leasing Co. was active on Chollar and Potosi ore; and the new Comstock Phoenix mill in Six Mile Canyon was operated. At Tonopah, 7 milling plants, using principally the cyanide process, treated a large tonnage of siliceous silver ore. In the Manhattan camp 4 mills operated. A

new cyanide plant was nearly completed at Aurora to treat gold ores; it is equipped with 40 stamps and 6 tube mills. There were 71 milling plants of various kinds in operation in Nevada during 1913. Most of these were operated for short periods. There were 23 plants using the amalgamation process, 13 amalgamation and concentration plants, 3 amalgamation and cyanidation plants, 6 concentration and cyanidation plants—20 were straight cyanide mills and 6 straight concentration mills. Of the 1,451,485 tons of ore treated at gold and silver mills, 360,579 tons were treated by amalgamation and yielded 64,282.75 ounces of gold and 33,581 ounces of silver, or an average recovery of $3.68 in gold and 0.093 ounce of silver per ton. The ore treated by cyanidation aggregated 1,090,906 tons, which, with 54,172 tons of old tailings, yielded 403,267.05 ounces of gold and 11,890,016 ounces of silver, or an average recovery per ton for ore and tailings of $7.24 in gold and 10.38 ounces of silver. The total value of the bullion recovered from ore and tailings was $16,866,965, as against an output in 1912 amounting to $17,182,140.

Mills equipped for the concentration of low-grade ore treated 3,451,549 tons, or more than 64 per cent of the total ore sold or treated. The concentrates produced aggregated 501,888 tons, containing 49,127.37 ounces of gold, 2,135,714 ounces of silver, 70,049,254 pounds of copper, 5,162,159 pounds of lead, and 8,035,455 pounds of zinc (spelter), valued in all at $13,840,279, or an average value of $27.56 per ton. The two tables following give the quantity of ore concentrated, and of concentrates with their metallic content by counties; also the production by kinds of concentrates, and the averages for 1911–1913:

Mine production of gold, silver, copper, lead, and zinc from Nevada concentrates in 1912.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Churchill	.....	598	1,422.00	148,114	4,292	.....	.....	$119,521
Clark	16,756	16,646	121.08	176,872	222	5,052,103	8,035,455	781,647
Elko	.....	17	48.03	24	.....	.....	.....	1,008
Esmeralda	9,168	708	2,130.89	7,627	89,843	.....	.....	62,582
Eureka	.....	37	3.88	4,206	335	2,939	.....	2,801
Humboldt	.....	36	2,084.79	7,495	.....	.....	.....	47,623
Lander	292	73	98.12	1,667	88	.....	.....	3,049
Mineral	.....	7	30.47	9	.....	.....	.....	635
Nye	.....	3,098	14,801.66	1,605,441	318	.....	.....	1,275,713
Storey	5,320	1,124	8,140.42	98,252	1,549	4,037	.....	228,039
Washoe	835	140	8.03	20,066	1,757	103,080	.....	17,094
White Pine	3,419,178	479,404	20,238.00	65,941	69,950,850	.....	.....	11,300,567
Total	3,451,549	501,888	49,127.37	2,135,714	70,049,254	5,162,159	8,035,455	13,840,279

By kinds of concentrates.

Dry or siliceous	5,027	26,747.48	1,865,416	6,440	8,444	.....	$1,681,001
Copper	480,116	22,377.89	73,646	70,041,011	.....	.....	11,363,431
Lead	3,103	2.00	133,649	1,803	3,412,030	.....	231,173
Lead-zinc	13,642	.....	63,003	.....	1,741,685	8,035,455	564,674

Kinds of concentrates and average metallic content of each kind produced in Nevada in 1911–1913.

Kind and source of concentrates.	Quantity of ore.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
Dry or siliceous:	*Short tons.*	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Gold and silver mills—							
1911	25,970	$47.72	92.00	0.02	.....	.....	$96.54
1912	5,106	154.17	386.86	.06	0.28	.....	392.54
1913	4,449	104.61	406.00	.07	.09	.....	350.14
Concentration mills—							
1911	243	27.69	160.03	.07	.97	.....	113.55
1912	500	122.94	66.89	3.82	.36	.....	176.89
1913	578	151.41	102.23	.....	.....	.....	213.17
Copper:							
Concentration mills—							
1911	242,099	1.76	.40	13.48	.....	.....	35.67
1912	329,585	1.40	.23	9.85	.....	.....	34.05
1913	480,116	.96	.15	7.29	.....	.....	23.67
Lead:							
Concentration mills—							
1911	895	1.17	56.13	.03	29.07	.....	57.15
1912	173	.32	67.37	.60	22.05	.....	63.60
1913	3,103	.01	43.07	.03	54.98	.....	74.50
Gold and silver mills—							
1911	26	84.81	85.31	.53	9.02	.....	139.46
Zinc:							
Concentration mills—							
1911	446	.....	6.47	.....	15.58	23.57	44.33
Copper-lead:							
Gold and silver mills—							
1911	30	26.03	18.40	6.10	37.96	.....	85.23
Lead-zinc:							
Concentration mills—							
1912	18,199	.....	11.31	.....	15.41	23.77	54.09
1913	13,642	.....	4.62	.....	6.38	29.45	41.39

There were two copper smelting plants in operation in Nevada in 1913.

Mine production of gold, silver, copper, lead, and zinc from Nevada crude ore shipped to smelters in 1913.

By counties.

County.	Crude ore to smelters.						Total value.
	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
Churchill	106	21.76	19,346	.....	162	.....	$12,142
Clark	12,733	2,715.31	19,026	351,633	1,213,680	6,334,254	530,245
Douglas	43	24.33	33	1,873	.....	.....	813
Elko	1,855	308.47	40,465	200,342	361,880	.....	77,793
Esmeralda	23,579	18,719.78	130,014	1,198,976	288,674	.....	664,044
Eureka	1,837	733.03	45,905	55,050	495,165	.....	73,200
Humboldt	16,769	5,674.80	729,504	17,065	61,072	.....	563,261
Lander	1,163	560.98	73,000	119,552	121,466	.....	79,564
Lincoln	83,623	1,480.92	354,119	629,113	6,293,102	49,962	621,710
Lyon	206,864	131.28	3,873	15,106,475	4,595	.....	2,346,758
Mineral	13,229	536.19	106,094	769,536	59,632	.....	197,068
Nye	6,115	5,713.64	202,406	1,607	28,563	.....	241,869
Ormsby	62	2.86	477	3,923	3,734	.....	1,119
Storey	268	552.05	8,707	321	.....	.....	16,721
Washoe	901	75.15	41,492	133,384	94,599	.....	51,451
White Pine	30,031	648.88	128,067	2,021,670	731,575	.....	436,314
Total	399,178	37,899.43	1,902,528	20,610,520	9,757,899	6,384,216	5,914,072

By kinds of ore.

Dry or siliceous	104,229	17,000.21	1,442,861	14,642	4,381,761	.....	$1,417,981
Copper	269,909	16,741.09	168,188	20,077,061	2,097	.....	3,559,692
Lead	8,573	1,728.20	185,246	99,125	3,722,537	.....	326,770
Zinc	10,208	5.02	4,191	806	94,940	6,348,032	362,427
Copper-lead	6,197	2,424.91	102,042	418,886	1,541,907	.....	244,531
Lead-zinc	62	.....	.....	.....	14,657	36,184	2,671

Crude ore, by kinds, and average metallic content of each kind, produced in Nevada and shipped to smelters in 1911–1913.

Kind of crude ore.	Quantity of ore.	Average metallic content.					Average value per ton.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1911	67,584	$17.59	47.85	0.03	0.07	.....	$43.09
1912	60,830	11.24	17.94	.45	1.66	.....	25.26
1913	104,229	3.37	13.84	.....	2.10	.....	13.60
Copper:							
1911	32,789	.76	.42	3.08	.....	.....	8.68
1912	290,082	.09	.34	3.54	.....	.....	12.00
1913	269,909	1.28	.62	3.72	.....	.....	13.19
Lead:							
1911	3,180	5.08	45.80	.13	24.07	.....	51.33
1912	17,650	3.14	19.77	.80	12.39	.....	29.08
1913	8,573	4.17	21.61	.58	21.71	.....	38.12
Zinc:							
1911	3,013	.....	3.06	.01	3.00	32.36	41.24
1912	7,394	.01	.07	.....	.....	28.51	39.41
1913	10,208	.01	.41	.....	.46	31.09	35.50
Copper-lead:							
1911	216	4.55	45.49	5.47	16.99	.....	57.65
1912	168	.24	25.75	3.28	16.94	.....	42.16
1913	6,197	8.09	16.47	3.38	12.44	.....	39.46
Lead-zinc:							
1911	2,337	.12	8.52	.....	14.84	29.69	51.85
1912	676	.....	4.26	.....	6.51	33.48	54.69
1913	62	.....	.....	.....	11.82	29.18	43.08

A classification of kinds of crude ore smelted, separated into oxidized and sulphide ores, with average content, is shown in the two following tables:

Oxidized and sulphide crude ore, by kinds, including mixed dry ores and carbonate ores, produced in Nevada and shipped to smelters in 1913.

Kind of ore.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	104,229	17,000.21	1,442,861	14,642	4,381,761	.....	$1,417,981
Copper:							
Oxidized	67,304	917.69	69,873	5,434,160	1,268	.....	903,524
Sulphide	202,605	15,823.40	98,315	14,642,901	829	.....	2,656,168
Lead:							
Oxidized	6,452	1,158.76	134,341	76,628	2,689,201	.....	235,298
Sulphide	2,121	569.44	50,905	22,497	1,033,336	.....	91,472
Zinc:							
Oxidized	10,136	.....	3,373	.....	93,027	6,298,070	358,822
Sulphide	72	5.02	818	806	1,913	49,962	3,605
Copper-lead:							
Oxidized	6,189	2,424.91	101,834	418,394	1,540,235	.....	244,256
Sulphide	8	.....	208	492	1,672	.....	275
Lead-zinc:							
Sulphide	62	.....	.....	.....	14,657	36,184	2,671
Total	399,178	37,899.43	1,902,528	20,610,520	9,757,899	6,384,216	5,914,072

Oxidized and sulphide crude ores, averages per ton, by kinds, produced in Nevada and shipped to smelters in 1912 and 1913.

Kind of ore.	Quantity of ore.	Average metallic content.					Total value.
		Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	
	Short tons.	*Value per ton.*	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*	
Dry or siliceous:							
1912	60,830	$11.24	17.94	0.45	1.16	.....	$25.26
1913	104,229	3.37	13.84	.....	2.10	.....	13.60
Copper:							
Oxidized—							
1912	147,703	.17	.62	3.19	.....	.....	11.09
1913	67,304	.28	1.04	4.04	.....	.....	13.42
Sulphide—							
1912	142,379	.....	.04	3.92	.....	.....	12.96
1913	202,605	1.61	.49	3.61	.....	.....	13.11
Lead:							
Oxidized—							
1912	14,111	2.31	11.81	.58	8.57	.....	20.37
1913	6,452	3.71	20.82	.59	20.84	.....	36.47
Sulphide—							
1912	3,539	6.45	51.51	.26	27.59	.....	63.83
1913	2,121	5.55	24.00	.53	24.36	.....	43.13
Zinc:							
Oxidized—							
1912	7,309	.....	.....	.....	.....	28.38	39.16
1913	10,136	.....	.33	.....	.46	31.06	35.40
Sulphide—							
1912	85	1.04	6.00	.....	.....	40.08	60.04
1913	72	1.44	11.36	.56	1.33	34.70	50.07
Copper-lead:							
Oxidized—							
1912	91	.19	33.78	3.39	23.59	.....	53.36
1913	6,189	8.09	16.45	3.38	12.44	.....	39.47
Sulphide—							
1912	77	.30	16.27	3.16	9.09	.....	28.92
1913	8	.....	26.00	3.08	10.45	.....	34.37
Lead zinc:							
Oxidized—							
1912	676	.....	4.26	.....	6.51	33.48	54.69
1913	.....	.....	.....	.....	.....	.....	.....
Sulphide—							
1912	.....	.....	.....	.....	.....	.....	.....
1913	62	.....	.....	.....	11.82	29.18	43.08
Total, 1912	376,800	2.03	4.10	2.84	.87	.62	15.57
1913	399,178	1.96	4.77	2.58	1.22	.80	14.82

The following tables show the State output by counties, with the corresponding metallic output and total value; also the tonnage, number of mines, and average value for each county compared for 1912 and 1913:

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1913, by counties.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Churchill			15,630.15	$323,104	$323,104	1,383,257	$835,487
Clark			6,970.35	144,090	144,090	198,922	120,149
Douglas	38.99	$806	25.30	523	1,329	39	24
Elko	71.98	1,488	2,499.87	51,677	53,165	45,482	27,471
Esmeralda	6.92	143	276,750.18	5,720,934	5,721,077	188,361	113,770
Eureka	73.10	1,511	758.08	15,671	17,182	56,996	34,426
Humboldt	623.94	12,898	14,785.62	305,646	318,544	757,505	457,533
Lander	1,313.96	27,162	3,615.26	74,734	101,896	122,009	73,693
Lincoln			3,082.84	63,728	63,728	475,105	286,963
Lyon	38.31	792	1,838.11	37,997	38,789	7,666	4,630
Mineral	8.22	170	6,034.11	124,736	124,906	228,832	138,215
Nye	12,600.33	260,472	158,540.70	3,277,327	3,537,799	11,634,033	7,026,956
Ormsby			244.20	5,048	5,048	2,469	1,491
Storey			41,291.16	853,564	853,564	729,972	440,903
Washoe			2,826.41	58,427	58,427	64,719	39,090
White Pine			20,921.32	432,482	432,482	194,716	117,609
Total	14,775.75	305,442	555,813.66	11,489,688	11,795,130	16,090,083	9,718,410

County.	Copper.		Lead.		Zinc (spelter).		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Churchill	4,292	$665	162	$7			$1,159,263
Clark	351,855	54,537	6,265,783	275,694	14,369,709	$804,704	1,399,174
Douglas	1,873	290					1,643
Elko	200,342	31,053	361,880	15,922			127,611
Esmeralda	1,288,819	199,767	288,674	12,702			6,047,316
Eureka	55,385	8,585	498,104	21,917			82,110
Humboldt	17,065	2,645	61,072	2,687			781,409
Lander	119,640	18,544	121,466	5,344			199,477
Lincoln	661,494	102,532	7,701,311	338,858	49,962	2,798	794,879
Lyon	15,106,475	2,341,504	4,595	202			2,385,125
Mineral	769,536	119,278	59,632	2,624			385,023
Nye	1,925	298	28,563	1,257			10,566,310
Ormsby	3,923	608	3,734	164			7,311
Storey	1,870	290	4,037	178			1,294,935
Washoe	135,141	20,947	197,679	8,698			127,162
White Pine	71,974,116	11,155,988	747,331	32,883			11,738,962
Total	90,693,751	14,057,531	16,344,023	719,137	14,419,671	807,502	37,097,710

Tonnage of ore sold or treated, number of deep mines producing, and average value per ton of ores in Nevada in 1912 and 1913, by counties.

County.	Ore sold or treated (short tons).		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	1913	Increase (+) or decrease (−).	1912	1913	1912	1913	1912	1913
Churchill	83,901	+ 25,467	10	12	$21.24	$13.82	$21.22	$13.81
Clark	36,355	+ 3,327	42	47	43.40	38.48	5.91	7.27
Douglas	44	− 30	7	4	31.23	18.93	14.25	12.34
Elko	5,168	− 8,538	45	43	10.07	24.40	8.71	15.31
Esmeralda	538,241	− 20	64	57	13.42	11.24	13.23	10.84
Eureka	2,897	− 19,161	22	42	6.75	27.82	6.13	17.29
Humboldt	25,585	+ 11,082	68	114	70.14	30.03	69.47	29.82
Lander	27,709	+ 9,056	32	35	8.50	6.21	7.45	5.35
Lincoln	96,555	+ 2,454	19	22	12.64	8.23	6.59	3.63
Lyon	210,289	− 33,395	45	52	11.82	11.34	.27	.20
Mineral	29,334	+ 17,750	114	83	30.82	13.12	22.61	8.96
Nye	696,779	+121,037	75	98	15.97	14.78	15.97	14.78
Ormsby	1,057	+ 198	5	4	11.86	6.92	11.82	6.19
Storey	157,562	+ 45,561	30	36	12.07	8.22	12.07	8.22
Washoe	6,402	+ 3,713	43	47	24.10	19.86	18.17	15.23
White Pine	3,449,333	+424,745	20	26	3.87	3.40	.18	.16
Total	5,367,211	+603,246	641	722	8.00	6.85	4.63	3.95

[a] Value per ton, placer product excluded.

Number of producing placer mines and production in Nevada in 1912 and 1913, by counties.

County.	1912						1913					
	Hydraulic.	Drift.	Dredge.	Gold.	Silver.	Total value.	Hydraulic.	Drift.	Dredge.	Gold.	Silver.	Total value.
				Value.	*Fine ounces.*					*Value.*	*Fine ounces.*	
Clark	1	....	....	$98	.....	$98	....	....	....	.....	.....	.....
Douglas	....	1	....	538	5	541	1	....	....	$806	6	$810
Elko	4	....	....	771	29	789	1	....	....	1,488	28	1,505
Esmeralda	1	....	....	93	2	94	1	....	....	143	2	144
Eureka	8	1	....	10,301	34	10,322	4	....	....	1,511	5	1,514
Humboldt	5	....	....	2,787	17	2,797	6	....	1	12,898	238	13,042
Lander	9	....	....	10,605	87	10,659	11	1	....	27,162	188	27,275
Lyon	2	....	....	250	6	254	2	....	....	792	19	803
Mineral	1	1	....	1,693	82	1,743	1	....	....	170	10	176
Nye	16	10	....	204,312	4,207	206,899	15	20	....	260,472	5,867	264,016
Washoe	2	....	....	128	3	130	....	....	....	.....	.....	.....
White Pine	1	....	....	77	2	78	....	....	....	.....	.....	.....
Total	50	13	....	231,653	4,474	234,404	42	21	1	305,442	6,363	309,285

REVIEW BY COUNTIES.

CHURCHILL COUNTY.

In 1913 12 deep mines in Churchill County produced 83,901 tons of ore, which was 25,467 tons more than was produced by 10 deep mines in 1912. The total average value per ton of this ore decreased from $21.24 in 1912 to $13.82 in 1913. The small quantity of copper and lead affects the total value only a few cents in either year. All but 106 tons of ore, which was shipped directly to the smelters, was of milling grade and produced $293,259 in gold, and 1,215,797 ounces of silver, valued in all at $1,027,600, or an average

value of $12.26 per ton. In addition to the gold and silver bullion, there was produced 598 tons of concentrate, carrying principally gold and silver and a little copper. The ore of shipping grade carried gold and silver. Comparison of the metal output of the county with that of 1912, shows a decrease in the production of all metals and in total value of $82,159.

Fairview district.—The bulk of the ore in 1913 was from the Nevada Hills mine, and was of milling grade, producing bullion and a small quantity of concentrate. The total output of the district reported by eight producers aggregated 41,952 tons of ore, yielding $125,940 in gold, 674,485 ounces of silver, 4,292 pounds of copper, and 162 pounds of lead, valued in all at $534,001, or an average value of $12.73 per ton. There were 27 tons of ore containing gold, silver, and a trace of lead shipped directly to the smelters.

The Nevada Hills property[1] produced 41,919 tons of milling ore, from which was recovered by cyanidation gold and silver bullion valued at $510,413.59, or an average recovery value of $12.18 per ton, representing a saving of 88.4 per cent of the gross value.

The total operating cost of $7.955 per ton is a decrease of $1.65 as compared to the cost of $9.60 for the previous year. * * * Exploration and development work totaling 35,660 feet to date has been performed on your property, 6,243 feet of which was done during the past year. * * * We believe that we have enough ore to run the mill at a profit for this year, but the future of the property depends upon further development.

Holy Cross district.—Ores produced from the Silver Star group yielded gold and silver, the output of one producer.

Jessup district.—Ore containing gold and silver was produced from the Gold King claim and shipped to the smelter.

Wonder district.—The entire output of the district was from the Nevada Wonder property, which produced 41,870 tons of ore, yielding gold and silver bullion extracted by the cyanide process.

From the Nevada property,[2] during 1913, 35,601 tons of ore, with a value of $14.42 per ton, were mined and sent to the mill, and 3,517 tons of dump ore, worth $16.69 per ton, were sent to the mill, making a total of 39,118 tons of ore, averaging $14.63, that were sent to the mill. * * * This ore contained 9,248 ounces of gold valued at $191,207.87, and 630,606 ounces of silver valued at $381,151.53, a total gross value of $572,359.40. From this was recovered 8,738 ounces of gold valued at $180,659.69 and 587,211 ounces of silver valued at $355,001, a total gross value of $535,660.69, showing a recovery of 93.1 per cent of the total metal contents and a recovery of 93.6 per cent of the gross value.

CLARK COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Clark County, Nev., in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1912	43	33,028	$49,740	236,465	173,887	6,555,565	13,254,860	$1,433,443
1913	47	36,355	144,090	198,922	351,855	6,265,783	14,369,709	1,399,174
Increase (+) or decrease (−) in 1913		+3,327	+94,350	−37,543	+177,968	−289,782	+1,114,849	−34,269

[1] Nevada Hills Mining Co. Ann. Rept. for year ending Dec. 31, 1913.

[2] Nevada Wonder Mining Co. Ann. Rept. for year ending Sept. 30, 1913.

The tonnage of ore mined by 47 producers was 36,355 tons in 1913. This is 3,327 tons greater than that produced by 42 producers in 1912. The total average value per ton decreased from $43.40 in 1912 to $38.48 in 1913. However, the gold and silver value in this ore increased from $5.91 in 1912 to $7.27 in 1913. The ore treated at concentration mills was 16,756 tons, yielding 16,646 tons of lead and zinc concentrates, which contained $2,503 in gold, 176,872 ounces of silver, 222 pounds of copper, 5,052,103 pounds of lead, and 8,035,455 pounds of zinc (spelter), valued in all at $781,647, or an average value of $46.96 per ton. The next largest tonnage was ore of shipping grade, of which 12,733 tons were shipped, containing $56,130 in gold, 19,026 ounces of silver, 351,633 pounds of copper, 1,213,680 pounds of lead, and 6,334,254 pounds of zinc, valued in all at $530,245, or an average value of $41.64 per ton. At gold and silver mills 6,866 tons of ore were treated, yielding $85,456 in gold and 3,024 ounces of silver.

Bunkerville district.—A small output of gold and silver bullion was reported from the district by one operator.

Eldorado Canyon district.—The total output consisted of 276 tons of ore, yielding $2,590 in gold, 346 ounces of silver, and 297 pounds of copper, valued in all at $2,845. The principal part of the production came from the Rand property, on which is situated a 10-stamp mill equipped for amalgamation and concentration. This property is opened by a vertical shaft 510 feet deep and has an adit 880 feet long. The principal part of the output consisted of concentrates containing gold and silver bullion. The Skylark claim was also a producer of bullion and crude smelting ore.

Gold Butte district.—Oxidized copper ore was produced and shipped from one property in the district.

Searchlight district.—The total output consisted of 5,989 tons of ore, reported by 15 producers. The largest part of the production, or 5,593 tons, was treated at gold and silver mills, yielding bullion and a small quantity of concentrate. There were also 396 tons shipped directly to the smelter containing gold, silver, copper, and lead. The largest part of the ore mined was from the Quartette property. On August 21 the 40-stamp mill on the property was destroyed by fire. Ore was also produced from the Peerless, Elvira, Searchlight-Spokane, Eclipse, Southern Nevada, Good Hope, Duplex, and Anaconda properties.

Sunset district.—The Lucy Gray property was operated and the ore produced was treated by cyanidation, yielding a small quantity of bullion.

Yellow Pine district.—The reports from 25 producers gave a production of 29,060 tons of ore, containing $1,268 in gold, 192,339 ounces of silver, 283,592 pounds of copper, 6,204,065 pounds of lead, and 14,369,709 pounds of zinc, valued in all at $1,239,081. The bulk of the ore (16,756 tons) was concentrated, and was separated at lead and zinc plants, producing a lead and a zinc concentrate. There were also 12,304 tons shipped directly to the smelter, containing 61.32 ounces of gold, 15,750 ounces of silver, 283,546 pounds of copper, 1,153,430 pounds of lead, and 6,334,254 pounds of zinc. The producers were the Yellowpine Mining Co., St. Anthony, Prairie Flower, Potosi, Silver Gem, Monte Cristo, Hoodoo, Ingomar, Hoosier, Green Mountain, Milford & Addison, Frederickson, Clementina, Azurite, Annex, and Accident properties.

DOUGLAS COUNTY.

There were 4 deep-mine producers in Douglas County reporting the production of 44 tons of ore, which is 30 tons less than was reported by 7 producers in 1912. The total average value per ton decreased from $31.23 to $18.93 in 1913, and the gold and silver value in this ore from $14.25 to $12.34. The placer production amounted to $806 in gold and 6 ounces of silver.

Buckskin district.—Oxidized copper ore containing a small quantity of silver was shipped from one property in the district.

Gardnerville section (including Pine Nut and Mount Siegel districts).—The output of 1 placer and 1 deep mine yielded gold and silver bullion amounting to $830.

ELKO COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Elko County, Nev., in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	49	13,706	$86,887	54,058	75,722	138,857	$138,876
1913	44	5,168	53,165	45,482	200,342	361,880	127,611
Increase (+) or decrease (−) in 1913		−8,538	−33,722	−8,576	+124,620	+223,023	−11,265

[a] Includes placer production.

The yield of ore made by 43 producers was 5,168 tons in 1913, which is 8,538 tons less than was produced in 1912 by 45 producers. The total average value per ton increased from $10.07 in 1912 to $24.40 in 1913, and the gold and silver value in this ore from $8.71 to $15.31. The larger part (3,313 tons) of the ore was treated at gold and silver mills, and contained $44,307 in gold and 4,965 ounces of silver, valued in all at $47,306, or an average per ton of $14.28. There was also produced at one of these mills 17 tons of sulphide concentrate carrying gold and silver. The remainder of the ore was of shipping grade, aggregating 1,855 tons, which contained $6,376 in gold, 40,465 ounces of silver, 200,342 pounds of copper, and 361,880 pounds of lead, valued in all at $77,793, or an average of $41.94 per ton. The placer output amounted to $1,488 in gold and 28 ounces of silver.

Aura district.—Ore and a small amount of bullion were shipped from 2 properties in the district. The Jack Pot Bonanza was operated about 5 months, and a 5-stamp amalgamation plant on the property for about 10 days, testing the ores of the property.

Contact district.—Oxidized copper ore was shipped from the Delano property, and gold and silver ore from one other property.

Cornwall (Charleston) district.—During three months of 1913 a 5-stamp amalgamation and concentration mill of 15 tons daily capacity was experimentally operated on ore from the Marion property. Iron sulphide concentrates and gold bullion were produced. The figures of output are included with those of the Gold Circle district.

Dolly Varden district.—From the Morning Star property oxidized lead ore containing copper and silver and a trace of gold was shipped. There were two other shippers of ore whose names were not reported.

Ferber district.—The Salt Lake group and the Martha Washington property were producers of oxidized copper ore carrying gold and silver values.

Gold Circle district.—The output of the district made by 11 producers was valued at $34,746. The largest part of the ore produced, or 2,623 tons, was treated at gold and silver mills, yielding 1,585.75 ounces of gold, 1,211 ounces of silver, and 17 tons of concentrate containing 48.03 ounces of gold and 24 ounces of silver. There was also shipped from the district 3 tons of ore yielding gold and silver. The largest production of milling ore came from the Esmeralda property, and was treated in a 10-stamp amalgamation mill. Other producers were the Esperanza, Hardscrabble, and Midas. Also included is the output of the Marion property, located near Charleston, in the Cornwall Basin district.

Jarbidge district.—Four producers yielded 284 tons of ore, which contained $4,835 in gold and 126 ounces of silver. The larger part of the ore was treated at the 5-stamp amalgamation mill of the Alpha property, which is opened by an incline shaft 372 feet deep with an adit tunnel 420 feet long.

Merrimac district.—Ore produced from the Copper Queen and Baltimore-Morgan properties aggregated 516 tons. All of the output was of shipping grade and carried gold, silver, copper, and lead.

Mountain City district.—The Van Duser placer produced a small amount of gold bullion.

Railroad district.—Six producers reported 593 tons of ore, yielding $303 in gold, 19,202 ounces of silver, 54,645 pounds of copper, and 187,219 pounds of lead, valued in all at $28,608. All of this ore was of shipping grade, and was produced from the Helen M., Nevada Bunker Hill, Sweepstake, and Sylvania.

Spruce Mountain district.—Oxidized lead ore, with values in silver and a little gold, was shipped from the Keystone property in 1913.

Tecoma district.—The Jackson group produced oxidized lead ore carrying silver and a little gold and copper, shipped to the smelters from Gartney on the Southern Pacific Railroad.

Tuscarora district.—The Dexter & Nevada Queen, part of a group of rich mineral claims, were turned over to lessees during 1913. In the aggregate the production was quite important. Eight operators reported the production of 394 tons of ore, yielding $9,562 in gold, 9,699 ounces of silver, and 1,994 pounds of lead, valued in all at $15,508. All of the ore was treated at milling plants with the exception of 26 tons containing lead, shipped directly to the smelter.

ESMERALDA COUNTY.

Mine production of gold, silver, copper, and lead and number of producers in Esmeralda County, Nev., in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	65	538,261	$7,014,559	175,731	593,764	118,608	$7,225,942
1913	58	538,241	5,721,077	188,361	1,288,819	288,674	6,047,316
Increase (+) or decrease (−) in 1913		−20	−1,293,482	+12,630	+695,055	+170,066	−1,178,626

[a] Includes placer production.

Fifty-seven producers in 1913, against 64 in 1912, mined 538,241 tons of ore, which was 20 tons less than the output of 1912. The total average value per ton decreased from $13.42 to $11.24 in 1913 and the gold and silver value per ton in this ore from $13.23 to $10.84. Nearly all of the ore (505,493 tons) was of milling grade and was treated principally by cyanidation, yielding $5,289,820 in gold and 50,716 ounces of silver, valued in all at $5,320,452, or an average value of $10.53 per ton. The ore shipped to smelters amounted to 23,579 tons, containing $386,972 in gold, 130,014 ounces of silver, 1,198,976 pounds of copper, and 288,674 pounds of lead, valued in all at $664,044, or an average value of $28.16 per ton. At mills where concentrators were in use 9,168 tons of ore yielded 708 tons of concentrates, containing $44,049 in gold, 7,627 ounces of silver, 89,843 pounds of copper, valued in all at $62,582, or an average value per ton of $88.39. The placer production of the county consisted of $143 in gold and 2 ounces of silver.

Basalt district.—Ore was shipped from the Tip Top group for testing purposes and contained gold and silver. A mill was constructed in the latter part of the year and started operations January 1, 1914.

Cuprite district.—A small output of oxidized lead ore, carrying a little silver, was shipped from the Ella property during the annual assessment work.

Goldfield district.—The table following shows the production of metals and ores in the Goldfield district from 1904 to the end of 1913:

Ore sold or treated in Goldfield district, Esmeralda County, Nev., in 1904–1913, and total content of gold, silver, copper, and lead.

Year.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	8,000	$2,341,979	19,954	.....	.....	$2,353,353
1905	(a)	1,882,951	8,589	.....	.....	1,888,139
1906	59,628	7,026,154	15,648	.....	.....	7,036,638
1907	101,136	8,408,396	71,710	.....	.....	8,455,725
1908	88,152	4,880,251	30,823	1,606	.....	4,896,799
1909	297,199	9,383,261	33,164	52,015	.....	9,407,268
1910	339,219	11,137,150	117,598	107,282	.....	11,214,278
1911	390,431	10,287,075	126,406	72,998	.....	10,363,195
1912	362,777	6,239,747	125,736	579,539	3,581	6,412,859
1913	364,785	5,019,419	153,984	1,257,319	16,063	5,308,017
Increase (+) or decrease (−) in 1913	+2,008	−1,220,328	+28,248	+677,780	+12,482	−1,104,842

a Tonnage not reported.

The ore output of 25 deep mines aggregated 364,785 tons, containing, with the bullion from one small placer, $5,019,419 in gold, 153,984 ounces of silver, 1,257,319 pounds of copper, and 16,063 pounds of lead, valued in all at $5,308,017, or an average value per ton of $14.55. The bulk of the output, or 333,582 tons, was treated at cyanidation plants and yielded 222,653.51 ounces of gold and 38,714 ounces of silver. At concentration plants 9,168 tons of ore yielded 708 tons of concentrate, containing 2,130.89 ounces of gold, 7,627 ounces of silver, and 89,843 pounds of copper. The smelters received 22,034 tons of ore, containing 18,018.58 ounces of gold, 107,639 ounces of silver, 1,167,476 pounds of copper, and 16,063 pounds of lead. A large tonnage of concentrates was produced at

the mill on the Goldfield Consolidated property and was reduced in furnaces erected for that purpose in the vicinity. However, the bullion from the product is credited to gold and silver mills. Production of ore was also reported from the Florence Goldfield, Diamondfield Daisy, Belmont, Goldfield Merger, Jumbo Extension, Nevada Eagle, and Vernal properties.

According to the annual printed statement of the Goldfield Consolidated Mines Co.,[1] during the year 349,465 tons of ore were produced, of which 330,217 tons were milled and 19,248 tons shipped to custom smelters, resulting in a net realization of $2,731,944.87.

Ore production, values, and average per ton of ore.

	Production (short tons).	Total value.	Average per ton.
Tons milled	330,217	$4,911,568.97	$14.88
Loss in tailing		391,554.72	1.19
Value recovered		4,520,014.25	13.69
Tons shipped	19,248	527,284.12	27.39
Smelter discount		96,106.76	4.99
Smelter settlements		431,177.36	22.40
Total production	349,465	4,951,191.61	14.17
Cost of ore purchased		8,363.25	.03
Value realized		4,942,828.36	14.14

Production by shafts.

Shaft.	Milling ore.			Shipping ore.		
	Short tons.	Average.	Value.	Short tons.	Average.	Value.
Combination	87,840	$15.17	$1,332,957.93			
Mohawk	132,642	13.31	1,765,345.86			
Red Top-Laguna	30,312	11.10	336,496.99			
Clermont-Jumbo No. 2	66,667	21.33	1,422,271.00			
Clermont				19,248	$27.39	$527,284.12
Dumps	12,756	4.27	54,496.59			
Total	330,217	14.88	4,911,568.97	19,248	27.39	527,284.12

Operating conditions in the mines during the past year have been far from ideal and are becoming increasingly more difficult. This is due to the fact that in the early operations selective mining was practiced and only the higher-grade ore extracted. The result is that 90 per cent of our present tonnage is coming from the pillars, ends, and sides of old stopes from which the higher-grade ore has been removed. Notwithstanding this handicap, mining costs increased only $0.02 per ton over the previous year, being $3.41 per ton, as against $3.39 for the year 1912. * * * Total operating costs, including both construction and the full cost of marketing the ore shipped, were $6.38 per ton, as against $6.92 per ton. * * * In the lower levels shipping ore only is found; and our experience, as well as that of some of our neighbors, teaches us that our possibilities in that direction are by no means exhausted, but development there on account of heat and water and the large territory to be covered is necessarily slow. Large bodies of low-grade ore have frequently been referred to in previous reports, and while it is true that we are now mining the ore as it comes so long as each ore body mined yields, as a whole, a

[1] Ann. Rept. for the year ending Dec. 31, 1913.

margin of profit, it is also true that the mines contain large masses of rock, the gross contents of which, per ton, are far below our present working costs per ton. Experiments have been made during the past year for the purpose of working out some modified plans for mining and milling by which this rock can be made a valuable asset, but thus far without success. The tonnage available, however, is large enough to justify persistent effort along these lines, and the experiments will be continued. * * * By the foresight of previous managements the mill tailing has been impounded from the beginning of operations and represents an asset that will be available in the future. Careful experiments have shown that the tailing can be subjected to further treatment resulting in a net profit of a few cents per ton, and plans for equipment to handle this material are practically complete. The equipment will be installed at the proper time and about five years will be required to complete the treatment after operations begin.

The Florence-Goldfield Mining Co.'s annual report states:

From the Florence-Goldfield mine[1] 4,306.86 dry tons of ore were mined and shipped. Of this amount 3,159.22 tons were treated in the cyanide plant of the Jumbo Reduction Co.'s mill at Bonnie Clare, Nev., which was leased to the company. The gross value recovered from the 3,159 22 tons was $28,889.53, or a recovered value of $9.11 per ton, which represents an average extraction of about 86 per cent. From the latter part of November to the close of the year 987.66 dry tons were shipped to the Belmont Milling Co. and the Western Ore Purchasing Co., the gross value being $12,069.32, or $12.22 per ton. * * * After the shaft was sunk to a depth of 1,260 feet productive ore was not found; * * * and because the funds of the company were not large it was deemed best to confine the work to the upper levels, where there was a probability of discovering other productive ore bodies.

During 1913 the Jumbo Extension mine[2] yielded 11,210 tons of ore, of which 10,676 dry tons were milled and 533.6 tons were shipped. There was realized for the gold and silver content $88,636.03, or an average per ton of $7.91. The mill ore was transported to the Bonnie Clare mill, 38 miles from Goldfield, and there concentrated. The company lost by this transaction, and future ore production is to treated at the Consolidated mill at Goldfield, commencing June 6, 1914.

Gold Mountain district.—Six producers of ore reported a yield of 264 tons, containing $5,037 in gold, 3,512 ounces of silver, and 2,957 pounds of lead, valued in all at $7,288. Gold and silver ore was produced from the Tonopah Divide, the Imperial, and the Nevada Crown properties.

Hornsilver district.—Lessees operated on the Silver Tip No. 1 and No. 2 claims, producing a small quantity of silver ore, which contained a trace of gold.

Lida district.—The production reported by 11 producers aggregated 57 tons of ore containing gold, silver, copper, and lead, with a total value of $4,147, or an average value of $72.75 per ton. The principal properties producing were the Bon Ami, Reward, Eagle Pass, Bisbee Calumet, and Blue Dick claims.

Lone Mountain district.—Of six producers in the district, the General Thomas had the largest output, consisting of lead ore containing a little copper, gold, and silver. Lead ore was also shipped from the Lone Mountain Alpine property.

Palmetto district.—From a prospect in the district a small quantity of lead ore containing silver was shipped to the smelter.

Silver Peak district.—The principal operations were carried on at the Mary mine, operated by the Pittsburg-Silver Peak Gold Mining

[1] Florence-Goldfield Mining Co. Ann. Rept. for year ending Dec. 31, 1913.
[2] Jumbo Extension Mining Co. Rept. for 17 months ending May 31, 1914.

Co., and an important tonnage of siliceous gold ores was treated in the 120-stamp mill and the 500-ton cyanide plant on the property. The mine has about 10 miles of drifts, of which 3,500 feet were accomplished in 1913.

Tokop district.—The largest lot of gold ore was shipped from the Camp Tokop claim, which has a vertical shaft 40 feet deep.

EUREKA COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Eureka County, Nev., in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	31	22,058	$128,190	28,307	19,861	230,710	$159,258
1913	46	2,897	17,182	56,996	55,385	498,104	82,110
Increase (+) or decrease (−) in 1913.		−19,161	−111,008	+28,689	+35,524	+267,394	−77,148

[a] Includes placer production.

The ore output of the mines in Eureka County was 2,897 tons, the yield of 42 producers. This is 19,161 tons less than was reported by 22 producers in 1912, when the largest part of the ore produced was of milling grade. In 1913 there were 1,837 tons of ore shipped directly to the smelter, yielding $15,153 in gold, 45,905 ounces of silver, 55,070 pounds of copper, and 495,165 pounds of lead, valued in all at $73,200, or an average value per ton of $39.85. The ore of milling grade treated at gold and silver mills was 1,060 tons, yielding $437 in gold and 6,880 ounces of silver; also 37 tons of concentrates containing gold, silver, copper, and lead. The placer bullion produced, the yield of four operators, amounted to $1,511 in gold and 5 ounces of silver, against a production of $10,301 in gold and 34 ounces of silver in 1912.

Eureka district.—In all, 26 producers reported the production of 1,096 tons of ore, yielding $13,227 in gold, 24,173 ounces of silver, 3,053 pounds of copper, and 287,959 pounds of lead, valued in all at $40,971, or an average of $37.38 per ton. The bulk of the ore, 1,086 tons, was of shipping grade, and 10 tons produced a small amount of gold and silver bullion. The principal producers were the Silver Conner, Silver Lick, Jackson, Distinction, Excelsior, Cyanide, Bullwhacker, and Pack Saddle properties.

Lynn district.—Reports from four placer operators show a production of $1,511 in gold and 5 ounces of silver, as against a yield of $10,301 in gold and 34 ounces of silver in 1912. Development of the quartz veins in the district continues to be promising, although no production has been reported.

Maggie Creek district.—The output of three producers aggregated 134 tons, containing gold, silver, copper, and lead, valued in all at $13,127, or an average value of $97.96 per ton.

Mill Canyon (Buckhorn) district.—No production was reported from the district in 1913, but the operators of the Buckhorn mine have 1,900 feet of development work performed on the property, including a 200-foot vertical shaft. The Buckhorn Co. completed the erection of an 800 horsepower plant at Beowawe, a 30-mile transmis-

sion line, and a 300-ton cyanide mill at Buckhorn, and started operations in January, 1914.

Emmons[1] describes the geology of the district, and more recently the Buckhorn mine has been described by Siebert:[2]

The property is 28 miles south of Beowawe, on the Southern Pacific Railroad, where the company's power plant is operated. The mine was discovered in the winter of 1908–9 by Joe Lynn, whose partners were W. S. McCrea, William Ebert, James Dwyer, and John Swan. Eventually, April, 1910, George Wingfield bought 14 claims and several fractions for $90,000. Since then 20,000 feet of work has been covered and a large tonnage of low-grade ore opened. There is no other mine with the same characteristics. The central core of the ore body is an intruded porphyry, augite andesite, intruded through many different alternating sheets of basalt and volcanic scoria. This central core has been the solution channel, and the gold and silver has been deposited over great widths in the beds of basalt and scoria, which have been favorable to ore deposition. These beds of scoria have been most favorable on account of their porous nature, but some of the softer basalt flows have also formed large deposits. So far as the work has progressed, it shows nine different basalt flows and a similar number of scoria beds. From the central core of the augite andesite the metal content decreases each way, and tonnage depends, therefore, upon the cost of production, but the commercial ore is in places at least 150 feet wide. The ore zone, so far as proved, is about 1,600 feet long. The first 100 feet in depth in the deposit includes practically all of the oxidized ore, which will be mined and milled first. The deposit to that point is almost vertical. It will be mined by the glory-hole system. Below this depth the deposit turns off rather flat and will be mined by the top-slice system, which is, in effect, the most up-to-date system of caving. No machine drills are used, as the ore is so soft. The main haulage level from the mine is 2,600 feet long, 1,750 feet of which is underground. Transportation is by electric locomotives. * * *

The Buckhorn mine produces an ore of a talcy nature, containing about 40 per cent silica. The scheme of treatment in the 300-ton mill under construction is as follows: Ore is dumped into a steel storage tank of 550-ton capacity, from which it passes over a shaking screen with 1-inch apertures, the oversize being crushed by a 10 by 20 inch Blake crusher. The crushed product and screen undersize go to a revolving trommel 12 by 36 inches, oversize going to 15 by 40 inch rolls, choke fed. Undersize from the trommel, with the roll product, is fed to a 6-foot Hardinge conical ball mill with spiral feed. Two bucket elevators, one being a stand-by, with 19-foot centers and a 12-inch belt, lift the pulp to two 45-inch Akins classifiers. These work in closed circuit with two 5 by 18 inch tube mills. The final overflow from the classifiers goes direct to the Dorr agitators. These are filled by a distributor, agitation being through the center column and distributor, the arms raking pulp to the center. Agitation is done in three vats in series. From these the slime goes to three Dorr thickeners, from which the thickened pulp is run to a second battery of three, here meeting with solution from revolving filters and other barren solution. The overflow from the second three flows into the first three, and overflow from the first three is precipitated by zinc dust. Slime is treated on four Oliver filters, and the residue is agitated by four vortex mixers and discharged.

Mineral Hill district.—The principal part of the district output was from the Mineral Hill Consolidated mines, which includes the Great Republic and Troy Consolidated, Spencer, North Pole, and Austin groups. The Pine Valley, Jackson Consolidated, and McCoy properties were also producers. The total output of the district aggregated 1,545 tons of ore, of which 1,050 tons produced gold and silver bullion and lead concentrate carrying a little copper, gold, and silver. There were 495 tons of ore shipped directly to the smelters containing 93.94 ounces of gold, 6,539 ounces of silver, and 42,889 pounds of copper, and 100,287 pounds of lead.

[1] Emmons, W. H., Reconnaissance of some mining camps in Elko, Lander, and Eureka counties, Nev.: U. S. Geol. Survey Bull. 408, pp. 100–110, 1910.

[2] Siebert, F. J., Min. and Sci. Press, Mar. 28, 1914, p. 547; also Min. and Sci. Press, Sept. 20, 1918, p. 452.

Safford district.—Outside of the production of iron ore from the West Mining Co., shipped from Barth to the American Smelters at Salt Lake City, there was also shipped by six producers 122 tons of ore, containing $14 in gold, 1,552 ounces of silver, 7,394 pounds of copper, and 3,584 pounds of lead, valued in all at $2,255, or an average value of $18.48 per ton.

HUMBOLDT COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Humboldt County, Nev., in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	73	14,503	$327,779	134,193	40,731	67,590	$1,020,071
1913	121	25,585	318,544	757,505	17,065	61,072	781,409
Increase (+) or decrease (−) in 1913		+11,082	−C09,235	+623,312	−23,666	−6,518	−238.662

[a] Includes placer production.

In 1913 there were 25,585 tons of ore mined, reported by 114 producers. This is 11,082 tons greater than was reported by 68 producers in 1912. The total average value per ton decreased from $70.14 in 1912, to $30.03 in 1913, and the gold and silver value in this ore from $69.47 to $29.82. The largest part of the ore was of shipping grade, aggregating 16,769 tons, containing $117,309 in gold, 729,504 ounces of silver, 17,065 pounds of copper, and 61,072 pounds of lead, valued in all at $563,261, or an average value per ton of $33.59. The ore treated at gold and silver mills was 6,916 tons, yielding $145,241 in gold, 20,268 ounces of silver, valued in all at $157,483, or an average value of $22.77 per ton. There were also 36 tons of gold and silver concentrates produced, valued at $47,623, or an average value of $1,322.80 per ton. Placers in the county produced $12,898 in gold and 238 ounces of silver, as against $2,787 in gold and 17 ounces of silver in 1912.

Amos district.—Gold ore with a little silver was treated in a 5-stamp amalgamation plant of the D. & C. Mining Co. The property is opened by an incline shaft 240 feet down and a number of open cuts on the surface.

Antelope district.—The Last Chance and Nevada-Superior properties yielded lead ore, largely oxidized, containing gold and silver, which was shipped to the smelter.

Cedar district.—Lead ore containing good values in gold and a little silver was shipped from this district by 2 producers in 1913.

Dun Glen, Central, or Chafey district.—Small lots of ore yielded, through the operations of 11 producers, 224 tons of ore, the larger part of which, or 153 tons, was milled, producing gold and silver bullion. According to the reports received, the production was $4,116 in gold, 1,601 ounces of silver, 7,602 pounds of copper, and 3,805 pounds of lead. Bullion was produced principally from the Black Hole and Mayflower claims.

Echo district.—A small quantity of ore containing gold and silver was produced from 2 properties.

Gold Run district.—Five operators reported the production of 3,282 tons of ore, the larger part of which, or 3,244 tons, was milled, yielding gold and silver bullion, and 38 tons, containing gold, silver, and lead with a little copper, were shipped directly to the smelters. The Kramer property of the Golconda Gold Ledge Co. produced the largest quantity of ore, which was treated in a Lane 10-foot mill, and yielded gold and silver bullion. The property is opened by 4 shafts, the deepest of which is 209 feet, and by 2 adits, 550 and 300 feet long. One shipment was made from the George Blaine lease on Silver Shield property, and consisted of lead ore carrying silver and a little gold.

National district.—The principal producer was the National mine, which was operated throughout the year, but the mill, which is a 5-stamp amalgamation and concentration plant, was operated only 10 days. A few pounds of very rich ore was also produced from the Buckskin property, which assayed $20,560.80 in gold and $715.72 in silver per ton. The geology of the district is described in Mineral Resources for 1911 and 1912.

Paradise Valley district.—The Spring City dump of old tailings was worked, resulting in the production of a small quantity of gold and silver bullion. A small quantity of gold and silver bullion was also produced from two other claims and one placer.

Rochester district.—The value of the production in this district increased from $4,704, reported by 5 producers in 1912, to $477,487, reported by 34 producers in 1913. The tonnage of ore from 32 deep mines increased from 144 tons in 1912 to 16,152 tons in 1913, yielding $52,350 in gold, 701,395 ounces of silver, and 135 pounds of copper, valued in all at $476,014, or an average value per ton of $29.47. Placer operations reported from two different sources yielded $1,466 in gold and 12 ounces of silver. Nearly all of the ore (16,117 tons) was shipped directly to the smelters, and 35 tons produced bullion, the result of test lots of ore treated in milling plants. The largest producer of ore was the Codd lease, followed by the Big Four lease of the Rochester Hills Mining Co., both leases of the Rochester Mines Co. An important production was also made from the Weaver No. 2, and smaller lots of ore were shipped by lessees working various other properties. At Panama, across from the town of Rochester, in two small gulches, several miners were successful in cleaning up about $1,100 in placer gold during 37 days' work. The biggest nugget found was reported as having a value of $6.27. The bed rock is said to be within 2 or 3 feet of the surface and half of this depth was removed with plow and scraper and hauled for treatment about a mile and a half to water.

Rosebud district.—The output of four deep mines and one placer amounted to $2,095. There were 13 tons of ore produced, shipped directly to the smelter, which contained gold, silver, and a little copper. The Discovery, a placer property located 6 miles from Sulphur, was worked by rocker, yielding a small amount of gold and silver bullion.

Seven Troughs district.—The total output of ore of the district aggregated 2,066 tons, which produced $81,372 in gold and 21,788 ounces of silver, valued in all at $94,532, or an average value per ton of $45.76. A small quantity of gold and silver was recovered from surface workings, amounting to $76. The larger part of the ore

(1,860 tons) was treated at milling plants, principally by amalgamation and cyanidation. A small quantity of sulphide concentrate was saved. The largest producer was the Seven Troughs Mining Co., the Seven Troughs Coalition mine yielding the next largest quantity, followed by the output of the Mazuma Hills property.

Spring Valley district.—Old placer tailings were reworked by a dredging plant during 8½ months of the year on the Federal property.

Unionville district.—The Star Peak property, the Tiger, and one other property were the only producers in the district in 1913. Gold and silver bullion came from the treatment of ore in the Star Peak mill, and a small quantity of concentrates was also saved, carrying gold and silver.

Winnemucca Mountain district.—Reports of 10 producers show the yield of 145 tons of ore, containing $2,826 in gold, 928 ounces of silver, 5,236 pounds of copper, and 126 pounds of lead, valued in all at $4,205. Of this ore there were 83 tons treated at an amalgamation mill, yielding gold and silver bullion, and 62 tons were shipped directly to the smelter. The Gold Note and Rexall properties were the richest producers.

LANDER COUNTY.

The total output of the county amounted to $199,477. There were 27,709 tons produced by 35 operators, which is 9,056 tons more than was produced by 32 operators in 1912. There were 13,524 tons of ore treated at gold and silver mills, yielding $61,109 in gold and 47,154 ounces of silver, valued in all at $89,590, or an average value of $6.62 per ton. The ores of shipping grade aggregated 1,163 tons, containing $11,596 in gold, 73,000 ounces of silver, 119,552 pounds of copper, and 121,466 pounds of lead, valued in all at $79,564, or an average value per ton of $68.41. There were also produced in the county 292 tons of ore yielding 73 tons of concentrates containing gold and silver and a trace of copper. The placers yielded $27,162 in gold and 188 ounces of silver, produced by 12 operators, as against a production in 1912 of $10,605 in gold and 87 ounces of silver.

Battle Mountain district.—Ore and placer bullion, the yield of 15 deep-mine and 12 placer producers, amounted to $58,384. There were 546 tons of ore produced, of which the greater part, or 475 tons, was shipped directly to smelters and contained 101.63 ounces of gold, 13,535 ounces of silver, 116,574 pounds of copper, and 28,134 pounds of lead. The remainder of the ore (71 tons) yielded gold and silver bullion. The principal mines producing the larger part of the ore were the Copper Canyon and Copper Basin groups, Morning Star, Spanish, and Western Mines properties. The principal operations among the placers were carried on at the Kayak and Krackerjack claims, more generally known as the Christensen and Dahl properties. Other properties producing were the Blue Jay, Guy Davis, Grand View, and Homestake.

Bullion district.—The Aztec mine of the Maysville group produced oxidized ore carrying silver and a little copper and gold. This property is opened by tunnels and drifts aggregating 2,400 feet. It has two shafts 65 and 135 feet deep.

Cortez district.—The output of 6 producers of bullion from old tailings and ore shipped directly to smelters amounted to $42,503.

It is understood that the material treated by the Cortez Metal Co. was old tailing dumps and that the Garrison property was an important producer of lead oxidized ore containing silver and gold.

Hilltop district.—The output of 3 producers aggregated 10,065 tons, yielding $59,843 in gold, 7,849 ounces of silver, 88 pounds of copper, and 972 pounds of lead, valued in all at $64,640, or an average value per ton of $6.42. The principal producers were the Hilltop, Pittsburg Red Top, and Gray Eagle properties. The larger part of the output was treated at gold and silver mills, where the gold and silver was produced from the cyanidation of the ores.

Jackson district.—A small output of lead oxidized ore was shipped directly to the smelter from the Sunday mine. This property is equipped with a 3-stamp mill, but it was not operated in 1913.

Lewis district.—The Topsy and Estella claims produced silver ore which was shipped from Battle Mountain to the smelter.

Reese River district.—Eight producers reported the yield of 3,952 tons of ore, containing $4,123 in gold, 18,246 ounces of silver, 348 pounds of copper, and 922 pounds of lead, valued in all at $15,238, or an average value per ton of $3.86. The larger part of the ore was of milling grade, producing gold and silver precipitates from the operation of a 50-ton cyanide plant. The remainder of the ore produced (199 tons) was shipped directly to smelters and contained 33.39 ounces of gold, 11,211 ounces of silver, and the copper and lead already mentioned. Lessees operated on some claims of the Austin Manhattan property, and ore was also shipped from the New York Canyon property, and milling ores were produced from the property of the Maricopa Mines Co.

LINCOLN COUNTY.

Mine production of gold, silver, copper, lead, and zinc, and number of producers in Lincoln County, Nev., in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Zinc (spelter).	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1912	19	94,101	$152,862	759,371	492,098	10,759,685	68,128	$1,189,958
1913	22	96,555	63,728	475,105	661,494	7,701,311	49,962	794,879
Increase (+) or decrease (−) in 1913		+2,454	−89,134	−284,266	+169,396	−3,058,374	−18,166	−395,079

Twenty-two producers mined 96,555 tons of ore in 1913. This is 2,454 tons more than was reported by 19 producers in 1912. The total average value of the ore decreased from $12.64 in 1912 to $8.23 in 1913, and the gold and silver value of this ore from $6.59 to $3.63. The larger part of the output, aggregating 83,623 tons, was of shipping grade and yielded $30,614 in gold, 354,119 ounces of silver, 629,113 pounds of copper, 6,293,102 pounds of lead, and 49,962 pounds of zinc, valued in all at $621,710, or an average value of $7.43 per ton. At gold and silver mills 2,213 tons of ore were treated, yielding $7,825 in gold and 59 ounces of silver. No placer output was reported.

Bristol district.—The Home Run property was productive of a small tonnage of copper ore carrying silver and a trace of gold.

Caliente district.—In 1913 the Gold Chief mine was leased by the Standard Leasing Co., during which time an important quantity of ore was treated in the 50-ton cyanide plant on the property. The mill was reported not to be a perfect success and is being remodeled.

Comet district.—The New Lynden property was a producer of siliceous silver ore carrying gold and a trace of copper and lead. Tungsten ores are found in the district, but none were shipped in 1913.

Eagle Valley district.—Gold ore carrying a little silver was shipped from the Winner No. 2 prospect.

Ferguson district.—A small quantity of sweepings, the last clean-up of the Delamar mill, yielded a little gold and silver.

Jackrabbit district.—The Crescent Consolidated property yielded lead ore containing silver with a trace of gold and copper.

Pioche district.—The output of the district, produced by 14 operators, was 94,153 tons, including tailings, containing $54,375 in gold, 471,958 ounces of silver, 647,270 pounds of copper, 7,689,813 pounds of lead, and 49,962 pounds of zinc, valued in all at $780,915. Included in these shipments to the smelters were 10,709 tons of old tailings, which contained gold, silver, copper, and lead. The largest part of the ore and tailings output came from the Prince Consolidated properties and contained gold, silver, and lead. Most of the gold produced was contained in the old tailings, of which an important tonnage was shipped. The oxidized iron ore, assaying as high as 30 per cent iron, contained most of the lead and silver. The properties of the Day Bristol Consolidated, now in the hands of a receiver, were next in importance as a producer and shipped principally copper and copper-lead ore, also a small tonnage of zinc sulphide ore. The other producers were the Mendha, Roadside, Yuba East Half Moon, Amalgamated Pioche, and Telephone.

LYON COUNTY.

The production of 210,289 tons of ore, reported by 52 producers, is 33,395 tons less than was reported by 45 producers in 1912. The total average value, however, remained about the same, decreasing from $11.82 to $11.34, and the gold and silver value in this ore from 27 cents to 20 cents. The bulk of the ore produced was of smelting grade and aggregated 206,864 tons, containing $2,713 in gold, 3,873 ounces of silver, 15,106,475 pounds of copper, and 4,595 pounds of lead, valued in all at $2,346,758, or an average value per ton of $11.34. There were 3,425 tons treated at gold and silver mills, yielding $35,283 in gold, and 3,774 ounces of silver, valued in all at $37,562, or an average value per ton of $10.97. The placer production amounted to $792 in gold and 19 ounces of silver, as against a production in 1912 of $250 in gold and 6 ounces of silver.

Silver City district.—Twenty-six producers reported the production of 3,470 tons of ore, which yielded gold and silver bullion. From deep mines there was produced $36,050 in gold and 3,843 ounces of silver, valued in all at $38,371. All the ore was treated in gold and silver mills except 45 tons, carrying gold and silver, which was shipped directly to the smelters. The placer yield was $792 in gold

and 19 ounces of silver. Most of the ore produced was treated in the McTigue and Hamilton-Pollard custom mills, principally through the operations of lessees. The main producers were the Cook & Grey, Flora Temple, German, Haywood, Overland, Oest, and Vivian properties.

Talapoosa district.—Ore taken from the shallow workings of the Talapoosa property was shipped directly to the smelter and yielded mostly silver with some gold.

Yerington district.—Although two properties in the district yielded most of the ore, there were altogether 25 producers reporting the yield of 206,558 tons of ore, containing $727 in gold, 295 ounces of silver, 15,106,475 pounds of copper, and 4,595 pounds of lead, valued in all at $2,342,611. All of the ore was of smelting grade, and the entire output, with the exception of ore containing lead, was treated at the smelter of the Mason Valley Mines Co., at Thompson.

According to the statement of the Mason Valley Mines Co.[1]—

The tonnage smelted during the year was 227,855 tons, of which 116,636 tons were from the company's property and 111,219 tons custom ore. From the above there was produced 17,166 tons of copper matte, containing 14,601,520 pounds of copper, 9,922.73 ounces gold, and 121,834.74 ounces silver. * * * The shrinkage stope system has been employed and found to be satisfactory and economical. The ore shipments have been governed by the requirements of the smelter, and have been varied to assist in the treatment of custom ores. * * * The combined smelting capacity of the plant since the enlargement of the two blast furnaces is 1,800 tons of ore per day. All the equipment necessary for the sampling and smelting of this tonnage is in first-class condition. The converting plant is capable of handling the matte resulting from the smelting of this ore. * * * The product of the smelter has been a copper matte containing approximately 40 per cent copper. This matte has been shipped to the Garfield Smelting Co.'s plant, near Salt Lake, for converting. * * * A copper converting plant was added to the smelter during the year. Two stands of converters were installed. The converters were started January 3, 1914. * * * Experiments have been conducted with a view of treating the heavy sulphide ores of Shasta County, Cal., and approximately 75 tons a day of this ore is being received at the present time.

The Nevada-Douglas mines shipped an important tonnage of copper ores to the Mason Valley smelter at Thompson. It is reported that new and extensive ore bodies were discovered in the Casting copper claim of the company, and large bodies of primary sulphides were developed on lower level of Ludwig mine. An experimental plant for the treatment of the Nevada-Douglas copper ores was started shortly after the close of 1913. The Rankin-Westling system of ore treatment is said to be in use.

MINERAL COUNTY.

Reports were received from 83 producers in 1913 giving an output of 29,334 tons of ore, which is 17,750 tons greater than that reported by 114 producers in 1912. The total average value per ton decreased from $30.82 in 1912 to $13.12 in 1913, and the gold and silver value in this ore from $22.61 to $8.96. The larger part (13,229 tons) was of smelting grade and contained $11,085 in gold, 106,094 ounces of silver, 769,536 pounds of copper, and 59,632 pounds of lead, valued in all at $197,068, or an average value of $14.90 per ton. There was also treated at gold and silver mills 10,668 tons of ore, yielding

[1]Ann. Rept. for year ending Dec. 31, 1913.

$113,022 in gold and 122,719 ounces of silver, valued in all at $187,144, or an average value per ton of $17.54. A small production of $170 in gold and 10 ounces of silver was recovered from (placer) surface workings. In 1912 the placer yield, chiefly from properties at Rawhide, amounted to $1,693 in gold and 82 ounces of silver.

Aurora (Cambridge) district.—The only production was the bullion output from old tailings from the Golden Fleece mine, which were treated at the Baldwin cyanide plant during part of the year. Automobiles reach this district by a 37-mile drive from Thorne, a station on the Southern Pacific Railroad at the south end of Walker Lake. Freighting is done from Hudson, a station on the Nevada Copper Belt Railroad, distant some 50 miles. It is reported that the Aurora Consolidated mine has 600,000 tons of gold ore measured up that will average $5.50 in gold per ton. To treat this, a 500-ton cyanide plant was practically finished in 1913, but will not be operated until some time in 1914. This mill consists of one 7½ and two No. 4 Gates crushers with a conveyor, designed to carry the ore from the crushing plant to the mill. The ore is passed through 8 stamp batteries of 5 stamps each, weighing 1,650 pounds, and then through six 6 by 16 foot tube mills, where it is ground to pass 200 mesh; from there it passes into three 32 by 12 foot Dorr thickening tanks and to 5 Dorr agitators, where it is treated for twelve hours. The ore then passes to 4 Trent continuous replacing machines, and from these it goes to the filters. The solutions go to clarification and precipitation presses. Bullion is made at the plant.

Buena Vista or Oneta district.—The Indian Queen property, situated in Queen Canyon, produced a carload of silver ore in October.

Columbus district.—About 30 years ago ore was hauled from Candelaria to Columbus and milled. The tailings from the old Columbus mill were treated by cyanidation in 1913, yielding gold and silver bullion. There was also shipped from three other properties 2,212 tons of ore containing 129.80 ounces of gold and 48.921 ounces of silver. The principal producers were the Lucky Hill, Bi-Metallic, and Mount Diablo.

Hawthorne district.—Reports were received from nine producers, showing a production of 452 tons of ore containing $2,395 in gold, 1,132 ounces of silver, and 38,131 pounds of copper, valued in all at $8,989. All the ore other than 57 tons treated at gold and silver mills was shipped directly to the smelter. The principal producers were the Pamlico, Northern Light, and Lucky Boy.

Klondyke district.—Reports were received from six producers and show a production of 747 tons of ore, yielding $1,565 in gold, 33,992 ounces of silver, 40,078 pounds of lead, and a few pounds of copper, valued in all at $23,868. The principal part of the output was the yield of the A, B, C, D group and the Original Klondyke property.

Mountain View district.—Output from the property of the Yerington Mountain Copper Co. yielded a sulphide copper ore containing a trace of silver. This property is opened by a vertical shaft 530 feet deep and 2,000 feet of drifts, and has an adit 2,600 feet long. The shipping station is Zais, on the Southern Pacific Railroad.

Pine Grove district.—Ore treated in the five-stamp amalgamation mill of the Wheeler property yielded gold and silver bullion. Some

old tailings treated by the cyanide process produced gold precipitates.

Rawhide district.—The ore output of 13 producers aggregated 9,954 tons. Most of this production was from the property of the Nevada New Mines Co., a reconsolidation of the Rawhide Coalition property, and was treated in the 10-stamp mill and 40-ton cyanide plant, yielding gold and silver bullion. There were also 61 tons of ore shipped directly to the smelters, which contained gold, silver, and a small quantity of copper. Important productions were also made from the Black Eagle, Bullskin, and Proskey Regent properties. Purchasers of gold bullion reported a small quantity of gold extracted from surface workings on several of the quartz properties.

Santa Fe district.—Twenty-nine producers reported the mining of 9,087 tons of ore, all of which, with the exception of 12 tons treated at a gold and silver mill, was shipped directly to the smelters. The total output of the district contained $1,576 in gold, 14,358 ounces of silver, 646,812 pounds of copper, and 6,933 pounds of lead, valued in all at $110,809, or an average value per ton of $12.19. The principal producer was the Anderson property, and others of importance were the Aviator, Guardian, Pacific Copper, Nevada Champion, Valley View, Independence, and Wagner properties. At the last-named property a leaching and amalgamation plant is under construction. In February, 1913, an option was obtained to purchase the Anderson group of claims.[1] This group consists of four claims and a fractional claim, located 4 miles from Luning, a station 80 miles south of Wabuska, on the Goldfield branch of the Southern Pacific Railroad. There have been 6,101 tons shipped from this property during 1913.

Silver Star district.—There were 14 producers reporting the output of 413 tons of ore, of which 315 tons were shipped directly to the smelters and 98 tons were treated at milling plants and produced gold and silver recovered by the amalgamation process. The ore of shipping grade contained $3,957 in gold, 3,799 ounces of silver, 12,512 pounds of copper, and 12,621 pounds of lead. The total output of the district amounted to $10,157. The principal producers were the Sunshine, Butcher Boy, Mohawk, Ipswich, and Black Cat.

NYE COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Nye County, Nev., in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	101	575,742	$3,123,935	10,210,296	427	4,352	$9,403,534
1913	133	696,779	3,537,799	11,634,033	1,925	28,563	10,566,310
Increase in 1913		121,037	413,864	1,423,737	1,498	24,211	1,162,776

[a] Includes placer production.

Ninety-eight producers in 1913 reported the output of 696,779 tons of ore, which is 121,037 tons greater than was produced by 75

[1] Mason Valley Copper Co. Ann. Rept. for year ending Dec. 31, 1913.

mine operators in 1912. The total average value of the ore, which is entirely for the gold and silver, decreased from $15.97 to $14.78 per ton. The bulk of the ore output was treated at gold and silver mills, yielding $2,853,113 in gold and 9,819,852 ounces of silver, valued in all at $8,784,304, or an average value per ton of $12.86. There were also produced at gold and silver mills 3,098 tons of concentrates, containing $305,978 in gold, 1,605,441 ounces of silver, and 318 pounds of copper, valued in all at $1,275,713, or an average value of $411.78 per ton. The tonnage of concentrates in 1913 is slightly greater than that produced in 1912, but as a rule it has been found more economical to treat ore directly by the cyanide process than by concentration of the sulphides containing gold and silver. Ores of shipping grade aggregated 6,115 tons and contained $118,110 in gold, 202,406 ounces of silver, 1,607 pounds of copper, and 28,563 pounds of lead, valued in all at $241,869, or an average value of $39.55 per ton. The placer production amounted to $260,472 in gold and 5,867 ounces of silver, as against a production in 1912 of $204,312 in gold and 4,207 ounces of silver.

Antelope Springs district.—Lessees shipped from the Antelope View, Chloride, and Western Union claims silver ore containing some gold. This property is opened by 3 incline shafts, 200, 195, and 100 feet deep.

Bellehellen district.—Ore carrying gold and silver was shipped from the Clifford property. A two-stamp mill was constructed and put in operation early in 1914.

Bullfrog district.—Ore reported by 6 producers aggregated 496 tons, containing $17,975 in gold, 4,518 ounces of silver, and 131 pounds of copper, valued in all at $20,724, or an average of $41.78 per ton. All but 49 tons of the ore, which was shipped directly to the smelter, was treated by cyanidation. Most of the bullion produced was cleaned up from the abandoned mill in the district. A 10-stamp amalgamation and cyanide mill erected on the Pioneer property was started in December.

Cloverdale district.—All of the ore produced by 5 operators (aggregating 97 tons) was shipped directly to smelters and contained $196 in gold, 7,679 ounces of silver, and 1,132 pounds of lead, valued in all at $4,484. The principal part of the production came from the Mammoth and Dalton claims.

Fluorine district.—The Bull Moose yielded gold ore, which was shipped directly to the smelter.

Gold Crater district.—A small production of ore carrying gold and silver was taken out by lessees.

Johnnie district.—Oxidized gold ore treated in the 80-ton amalgamation mill on the Johnnie property yielded gold and silver bullion. The property was in operation the entire year.

Manhattan district.—In 1913 there were 31 deep-mine and 34 placer producers reporting a production valued at $455,079. There were 46,228 tons of ore produced yielding $283,854 in gold and 4,516 ounces of silver, valued in all at $286,582, or an average value per ton of $6.19. The total placer bullion amounted to $166,622 in gold and 3,104 ounces of silver. The output of placers in 1912 was $168,512 in gold and 3,232 ounces of silver. The deep-mine output in 1912 was valued at $326,831. The principal part of the production from deep mines was from the White Caps and Big Four groups,

and other important productions were made from the Reilly Fraction, Crescent, Mustang, Jumping Jack, Liberty Fraction, Union No. 2, Union No. 9, Earl, Whale, May Flower, and Big Pine. Among the placers producing were the Jumbo, Fairview, Edith, Copenhagen, Mystery, Rainbow, Robust, Bright August, September, and Wolftone Extension.

The Associated Mill operated until the middle of May on ores mostly from the White Caps lease. From March until October the Big Four mill treated ore from its property. It is reported that the gold and silver ore treated from the Big Four property during the first part of 1913 averaged $8.32 per ton and gradually declined to a value no longer profitable, causing the mill to close. The East Side mill, a small five-stamp plant, treated some ores developed in the east Manhattan district. Custom work was performed almost continuously at the mill of the Manhattan Milling & Ore Co. The War Eagle mill, operated by the Commercial Mines & Milling Co., started operations in May on Reilly Fraction and some other ores.

Milletts district.—Four producers reported the production of 56 tons of ore containing $1,663 in gold, 222 ounces of silver, and 434 pounds of copper, valued in all at $1,864. Part of this output was treated at gold and silver mills, yielding gold bullion and concentrates, and 5 tons of ore were shipped directly to the smelters. The principal producer was the Nevada National property.

Round Mountain district.—The total output of deep mines and placers reported by 4 producers amounted to $364,390. There were 55,696 tons of ore treated at amalgamation mills on two properties. The principal producers were the Round Mountain Mining Co. and the Blue Jacket property.

Silver Bow district.—A two-stamp mill equipped with concentration device has been erected in the district, and it is expected to be in operation during 1914. A small lot of ore containing gold and silver was shipped as a test.

Tonopah district.—The production of the district from 1904 to 1913, inclusive, is shown in the following table:

Ore sold or treated in Tonopah district, Nye County, Nev., in 1904–1913, number of producers, and total content of gold, silver, copper, and lead.

Year.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1904	10	22,703	$386,526	2,119,942	.....	.....	$1,594,893
1905	12	91,651	1,206,345	5,369,439	.....	.....	4,449,486
1906	9	106,491	1,304,677	5,697,928	.....	.....	5,122,289
1907	10	214,608	1,183,628	5,370,891	5,939	195,508	4,739,966
1908	13	273,176	1,624,491	7,172,396	.....	.....	5,425,861
1909	9	278,743	1,400,361	7,872,967	1,784	1,488	5,494,600
1910	18	365,139	2,303,702	10,422,869	942	6,902	7,932,475
1911	19	404,375	2,366,495	10,868,268	.....	.....	8,126,677
1912	17	479,421	2,223,878	10,144,987	14	700	8,463,079
1913	32	574,542	2,613,843	11,563,437	1,150	9,001	9,598,733
Increase (+) in 1913	.....	+95,121	+389,965	+1,418,450	+1,136	+8,301	+1,135,654

Another record-breaking year in the total value of the district production—the output of 32 producers, amounting to $9,598,733—is recorded for the year 1913, as against an output valued at $8,463,079

in 1912, the production of 17 operators. There was an increase in the ore production from 479,421 tons in 1912 to 574,542 tons in 1913. From the ore produced in 1913 there was recovered 126,444.65 ounces of gold, valued at $2,613,843; 11,563,437 ounces of silver, valued at $6,984,316; 1,150 pounds of copper; and 9,001 pounds of lead. The average recovery value of this ore was $16.71 per ton, against an average recovery value of $17.65 per ton in 1912. The largest part of the ore (567,484 tons) was treated by cyanidation, with and without concentration, and yielded bullion containing 109,834.84 ounces of gold, 9,797,226 ounces of silver; and yielding also 3,094 tons of sulphide concentrate, which contained 14,792.66 ounces of gold and 1,605,363 ounces of silver. The average bullion recovery value of the ores cyanided was $14.43 and the average value of the concentrate was $412.22 per ton. Shipping ores aggregating 4,978 tons contained 1,811.03 ounces of gold, 160,381 ounces of silver, 1,150 pounds of copper, and 9,001 pounds of lead. This copper and lead probably originated in an outlying district. Shipping ores aggregated $134,883 in value, or an average value per ton of $27.10. There were also 2,080 tons of old tailings re-treated containing a small quantity of gold and silver.

Quite a new industry has sprung up in recovering from the slime ponds[1] the soluble silver salts which rise to the surface by the combined action of moisture in the dumps, heat of the sun, and capillary attraction, or, in other words, evaporation of weak cyanide solution which carries dissolved metal. The salts form a crust with the top one-eighth inch of slime, and are collected by scraping with garden hose or whisk brooms. A great deal depends on the weather, and warm weather is most desirable. The value of the product depends on the care taken by the men in scraping it up, as digging too deep is like adding waste to ore. I was told that the caliche, as it may be called, varies in value from $30 to $130 per ton, and will average $40 per ton, while the cost of scraping and treatment also varies, since one man can collect 2,000 pounds per day at $4, if the deposit is thick; but he will average only about 1,000 pounds with the usual thin layer. Then there is the company's royalty to be paid, which amounts to 35 per cent in one instance. At the Belmont mill, at Millers, the caliche is sampled, fed into a tube mill, and then mixed with the pulp, undergoing the usual treatment, while at the Extension it simply passes through with the ore after being sampled. One lessee ships his product to the Selby smelter at San Francisco. Even if the cost of collecting and treatment reaches $13 per ton (a figure given me as correct), there is a good profit in it for both the lessees and the companies.

The principal properties operating were the Tonopah-Belmont, Tonopah-Mining, Montana-Tonopah, Tonopah Extension, West End, Jim Butler, McNamara, Halifax, North Star, Tonopah-Merger, and Midway.

There were 172,646 dry tons of ore shipped from the Tonopah-Belmont mine[2] to the mill with an average gross value of $21.07 per ton. The sales of ore, bullion, and concentrates for the year contained 56,067 ounces of gold and 5,142,083 ounces of silver, for which the total receipts, after deduction of charges, amounted to $4,081,016. Dividends amounting to $1,650,000 were paid within the fiscal year, which make the total dividends paid since June, 1906, amount to $5,993,002. The new Belmont mill at Tonopah has treated 257,284 tons of ore of an average assay value of $21.57 per ton, at a total cost of $3.18 per ton, and with a recovery of 94.44 per cent. The saving in freight, milling costs, and recoveries over the best results ever ob-

[1] Von Bernewitz, M. W., Concentration of dissolved metals in slime ponds: Min. and Sci. Press, Jan. 18, 1913, p. 145.

[2] Tonopah Belmont Development Co. Ann. Rept. for year ending Feb. 28, 1914.

tained with the Millers plant amounts to $1.92 per ton. The saving on the ores treated to the end of the company's fiscal year amounts to $493,342.07, or $24,777.55 more than the cost of the new plant. The milling plant of the company at Millers was operated continuously on custom ores purchased in the district, treating in the period 48,088 dry tons, having an average value of $18.91 per ton. Of this tonnage 2,782 tons were old sand that was re-treated, 1,868 tons of slime residues collected by lessees were treated, and 43,438 tons of ores were purchased. A greater tonnage might have been secured, but much ore negotiated for proved by test not to be amenable to the cyanide process and was of necessity rejected. It was found necessary to discontinue the treatment of sweepings from the slime ponds of the district, because of the fouling of mill solutions that was traced to this material. The average extraction at the Millers plant for the year has been 87.39 per cent. Direct mining costs per ton of mill ore were $4.20 in 1913, as compared with $4.12 per ton for 1912. The increased cost is due wholly to increased development work.

From the property of the Tonopah Mining Co.[1] 167,747 tons of ore were treated by cyanidation, assaying $5.10 per ton in gold and 21.61 ounces of silver. The combined extraction of both gold and silver for the year was 87.52 per cent. The average gross value per ton of the ore milled for the fiscal year was $17.79, as compared with the previous year of $18.16 per ton. During the year the 100-stamp mill operated 95.9 per cent of the time, with an average tonnage per stamp of 4.65 tons of ore milled per 24 hours. The average costs per ton to mine the ore amounted to $3.28; milling, $2.81; freight on ore milled, 74 cents; marketing mill products, 58 cents; or a total cost of $7.41 per ton of ore. Metal losses in milling and refining amounted to $1.96 per ton and the profit to $8.42 per ton. Dividends paid for the year amounted to $1,300,000, making the total paid from April, 1905, to April, 1914, amount to $11,600,000.

The Tonopah Extension property[2] reports the treatment of 58,022.33 dry tons of ore. The total gold and silver contents of this ore was: 862,636.47 ounces of silver and 9,065,940 ounces of gold, or an average of 14.867 ounces of silver and 0.156 ounce of gold per ton, showing a decrease of 2,667 ounces in silver and 0.023 ounce in gold per ton under last year. The average price received for silver was $0.59041 per ounce, and $20.6718 per ounce was received for the gold, making the average value of the ore mined and milled $12,008 per ton. * * * The ore produced from the old workings came from drifts and stopes on the several different levels; a small tonnage of a good grade of ore coming from stopes on the north vein above the 270 and 400 foot levels, the bulk of the tonnage being produced from the south and lower contact veins on the 500 and 600 foot levels. * * * Work was continued on the three levels previously established, viz, 750 foot, 850 foot, and 950 foot. * * * This item of cost is $0.19 per ton of ore treated, compared with $0.233 for last year. During the year 58,022.33 tons were treated with an average stamp duty of 5.43 tons per day, compared with 54,618.11 tons with an average stamp duty of 5.18 tons per day for last year.

The West End Co. is enlarging its 20-stamp mill by the addition of 10 stamps, a tube mill, agitators, additional refining and boiler equipment, which will bring the mill to a capacity of 225 tons per day. The grade of the increased ore reserves in this property is about $20 per ton.

[1] Ann. Rept. for year ending Feb. 28, 1914.
[2] Tonopah Extension Mining Co. Ann. Rept. for year ending Mar. 31, 1914.

The Montana-Tonopah produced about 4,500 tons per month and operated its 40-stamp mill with good results. Late in 1913 several new ore bodies were encountered.

Tybo district.—Near Keystone is situated the Silver Top property, from which silver ore containing a little copper was shipped from an old dump. This old prospect was worked in the early days and has a 25-foot shaft.

Union district.—Old tailings were treated at the Berlin property, yielding gold and silver. There was also a small amount of gold and silver bullion produced from the Oddie property, taken out in doing assessment work.

Willow Creek district.—A small output of ore containing gold and silver was shipped from the property of the Willow Creek Mining Co.

ORMSBY COUNTY.

The reports of 4 producers show an output of 1,057 tons of ore, which is 198 tons greater than the output of 5 producers in 1912. The total average value per ton decreased from $11.86 to $6.92, and the average value for the last two years is practically that of the gold and silver content. The greater part of the county output is from the treatment of old mill tailings lodged along Carson River from the operations of the early Comstock mines. There were shipped directly to the smelters 62 tons of ore containing gold, silver, copper, and lead, and gold and silver were shipped to the United States mint.

STOREY COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in Storey County, Nev., in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	30	112,001	$855,494	806,883	1,322	3,612	$1,352,089
1913	36	157,562	853,564	729,972	1,870	4,037	1,294,935
Increase (+) or decrease (−) in 1913		+45,561	−1,930	−76,881	+548	+425	−57,154

Ore produced by 36 producers aggregated 157,562 tons. This is 45,561 tons greater than the output of 30 mine operators in 1912. The total average value of the district decreased from $12.07 to $8.22 per ton in 1913. The value in the ores is practically all for gold and silver, the copper and lead produced not changing the average. The bulk of the ore was treated at gold and silver mills and aggregated 128,629 tons, which, with 23,345 tons of tailings, yielded gold and silver bullion containing $673,875 in gold and 623,013 ounces of silver, valued in all at $1,050,175, or an average value of $6.91 per ton. There were 1,124 tons of concentrates saved from this ore and from 5,320 tons of ore concentrated. At the smelters these concentrates yielded $168,278 in gold, 98,252 ounces of silver, 1,549 pounds of copper, 4,037 pounds of lead, valued in all at $228,039, or an average value of $202.88 per ton.

Comstock district.—Thirty-six producers reported the output of 157,562 tons of ore and old tailings in 1913, having a total value of $1,294,935. The tonnage is greater, but the value is slightly less, than for the output of 1912, reported by 30 producers. In 1913 the larger part of the ore (128,629 tons), and 23,345 tons of tailings, were treated at gold and silver mills by the cyanidation process and yielded bullion containing 32,598.69 ounces of gold and 623,013 ounces of silver, valued in all at $1,050,175, or an average value per ton of ore and tailings of $6.91. There were also concentrates produced at these milling plants which, mixed with the concentrates produced at concentration mills, aggregated 1,124 tons, containing 8,140.42 ounces of gold, 98,252 ounces of silver, 1,549 pounds of copper, and 4,037 pounds of lead. Ore of shipping grade aggregated 268 tons, containing 552.05 ounces of gold, 8,707 ounces of silver, and 321 pounds of copper, valued in all at $16,721, or an average value of $62.39 per ton. The principal producers were the Mexican, Monte Cristo, Ophir, Yellow Jacket, Crown Point, Comstock Phoenix, Challar, and Belcher.

In 1913 the Mexican mine[1] produced 15,973 tons of ore, from which was recovered gold and silver averaging $25.35 per ton.

> At date of last report the stopes above our 2,300 [foot] level had been practically worked out, and we continued our extraction from the 2,400 and 2,500 [foot] level stopes. * * * The 2,400 [foot] stope was worked by the shrinkage method, which avoided the use of any considerable amount of timber. When the work was completed the ore was pulled from the stope and it was allowed to cave, according to the usual practice in such methods. * * * The Monte Cristo mine, in the lease upon which we have a 60 per cent interest, has been in operation throughout the year. Under our agreement with them we were to mill their ore in the Mexican mill, but we had not begun to do this until the latter part of March, 1913. Beginning at that time, we milled some 4,400 tons for them.

WASHOE COUNTY.

The yield of 6,402 tons of ore by 47 producers is 3,713 tons greater than the yield of 43 producers in 1912. The total value of this ore decreased from $24.10 to $19.86 per ton, and the gold and silver value from $18.17 to $15.23. The larger part of the tonnage (3,166 tons of ore and 1,500 tons of tailings) was treated at gold and silver mills and yielded $56,707 in gold and 3,161 ounces of silver. The ore of shipping grade aggregated 901 tons and contained $1,554 in gold, 41,492 ounces of silver, 133,384 pounds of copper, and 94,599 pounds of lead, valued in all at $51,451, or an average value of $57.10 per ton. At mills with concentrating devices there were treated 835 tons of ore, yielding 140 tons of concentrates, which contained $166 in gold, 20,066 ounces of silver, 1,757 pounds of copper, and 103,080 pounds of lead, valued in all at $17,094, or an average value of $122.10 per ton.

Leadville district.—The Donnelly Mountain and Tohoqua were the principal producers of gold ore and lead ore, the larger part of which was milled. Ores from the first-named property were treated in an amalgamation mill, and those from the Tohoqua property in a concentration plant yielding lead concentrates containing good values in silver and a little copper and gold.

[1] Mexican Gold & Silver Mining Co. Ann. Rept. for year ending Oct. 31, 1913.

Peavine district.—The principal production of copper ore came from the Red Metals mine in 1913. Similar ore was also produced from the Granite Hill property, which is reported to have an important tonnage of ore averaging 19.4 per cent of copper and $8 in gold and $5 in silver per ton.

Pyramid district.—Four miles southwest of Pyramid Lake, the Franco-American property, otherwise known as the Blondin, yielded a small tonnage of oxidized copper ore carrying silver and a trace of gold, which was shipped directly to the smelter. Shipments of similar ore were also made from several other properties in the vicinity.

Wedekind district.—Old tailings from the Wedekind properties were re-treated in a 20-ton cyanide plant, yielding bullion containing silver and a small quantity of gold.

White Horse district.—There was reported by 23 producers 1,767 tons of ore, which yielded principally gold and silver bullion. The total output of the district contained $43,466 in gold and 798 ounces of silver, valued in all at $43,948. Included in this was 1 ton of gold and silver concentrates and a small quantity of ore shipped directly to the smelter. The producers were the Keystone, Green Hill, Renegade, and Springfield-Nevada. These properties were worked by lessees, and most of them on a very small scale.

WHITE PINE COUNTY.

Mine production of gold, silver, copper, and lead, and number of producers in White Pine County, Nev., in 1912 and 1913.

Year.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1912	21	3,024,588	[a] 483,503	[a] 97,128	67,380,536	1,015,990	$11,706,745
1913	26	3,449,333	432,482	194,716	71,974,116	747,331	11,738,962
Increase (+) or decrease (−) in 1913		+424,745	−51,021	+97,588	+4,593,580	−268,659	+32,217

[a] Includes small placer production.

This county continues to be the largest producer of ore in the State, in 1913 yielding 3,449,333 tons, which is 424,745 tons more than was produced in 1912. The bulk of this ore is the production of one property in the Robinson district, at Ely. There were 26 producers reporting, against 20 in 1912, and the total average value of the ore produced decreased slightly from $3.87 to $3.40 per ton. The gold and silver value in this ore decreased from 18 cents to 16 cents per ton. Concentrating ores aggregating 3,419,178 tons produced 479,404 tons of concentrate, which yielded $418,357 in gold, 65,941 ounces of silver, and 69,950,850 pounds of copper, valued in all at $11,300,567, or an average of $23.57 per ton. There were also shipped directly to the smelters 30,031 tons of ore containing $13,414 in gold, 128,067 ounces of silver, 2,021,670 pounds of copper, and 731,575 pounds of lead, valued in all at $436,314, or an average value of $14.53 per ton.

Aurum or Silver Canyon district.—Oxidized iron ore containing some lead, gold, and a trace of copper was shipped from the Lucky Deposit property, situated in Silver Canyon on the west side of

Spring Valley. Similar ore was also shipped from the dump of the Siegel Consolidated property. The Greco-American also reported as a producer of lead ore.

Duck Creek district.—All of the ore produced by 5 operators, or 280 tons, was shipped directly to the smelters and contained $193 in gold, 1,018 ounces of silver, 100 pounds of copper, and 323,023 pounds of lead, valued in all at $15,036, or an average value per ton of $53.70. The lease on the Cuba property was productive of lead ore carrying silver with a trace of gold and copper. The principal producers, aside from the Cuba, were the Lead King and Ely Gibralter.

Eagle district.—Lead carbonate was produced from the Red Hills property. This ore contained silver, a little gold, and a trace of copper.

Hunter district.—The Vulcan mine was operated from May to the close of the year, and produced an important tonnage of shipping copper ore and copper-lead ore containing silver, a little copper, and gold. The property is situated 22 miles southwest of Cherry Creek and has approximately 2,500 feet of tunnel work.

Newark district.—The Battery claims, 18 miles east of Eureka, were worked under lease, and a few tons of lead ore containing silver and a little copper were shipped.

Osceola district.—A small quantity of gold and silver ore was shipped from the Cumberland property.

Pinto district.—The Washington and Morland property yielded silver ore carrying a small quantity of lead, gold, and a trace of copper, which was shipped directly to the smelter.

Robinson (Ely) district.—The following table shows the production of Robinson or Ely district from 1908 to 1913, inclusive:

Ore sold or treated in Robinson district, White Pine County, Nev., total content of gold, silver, copper, and lead, and number of producers, 1908–1913.

Year.	Number of producers.	Quantity of ore.	Gold.	Silver.	Copper.	Lead	Total value.
		Short tons.	*Value.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
1908	6	430,031	$94,443	30,381	14,797,295	2,381	$2,063,888
1909	10	1,671,225	370,569	79,487	57,481,515	524,512	7,907,053
1910	10	2,375,032	423,225	108,000	63,914,197	180,407	8,606,586
1911	4	2,776,930	435,287	101,107	67,033,547	10,216	8,870,118
1912	5	3,023,082	474,436	78,020	67,373,510	12,168	11,639,595
1913	3	3,447,812	430,347	68,793	71,916,711	15,756	11,619,681
Increase (+) or decrease (−) in 1913		+424,730	−44,089	−9,227	+4,543,201	+3,588	−19,914

An important consolidation during 1913 was that of the Giroux and a number of other properties to form the Consolidated Copper Mines Co. The steam shovels operating on the Nevada Consolidated are reported to have disclosed ore in the Ora claim of the Giroux property, causing further underground mining on that property to be discontinued in favor of steam-shovel mining. The principal producer of the district was the Nevada Consolidated mine[1] followed by the output from the Giroux property:

[1] Nevada Consolidated Copper Co. Ann. Rept. for year ending Dec. 31, 1913.

Mining has been carried out during the year at the Veteran by underground caving methods, and by steam shovels at the Eureka, Hecla, and Liberty pits. The pits are really on the one ore body, but the necessities of the conditions have made the divisions into three sections the natural result. The Eureka pit, as in the past, has furnished the largest tonnage, but in less proportion than during former years, as the Liberty and Hecla are being more thoroughly opened up. Due to the ore in the latter two pits being of lower grade than in the Eureka, the ore mined has shown a lower copper value than during previous years.

For the fiscal year just passed the following table shows the ore mined and shipped to the concentrator:

Operation of Nevada Consolidated copper mine, 1913.

	Short tons.	Percentage of copper.
Eureka pit	1,543,456	1.511
Liberty and Hecla pits	1,345,933	
Veteran	258,896	2.588
	3,148,285	1.597

Siliceous carbonate ore amounting to 29,971 dry tons and averaging 3.28 per cent copper was mined, all of which was crushed and delivered to the smelter.

The Nevada Consolidated Copper Co. during the latter half of 1913 also mined with its steam shovels ore for the Giroux Consolidated Mines Co. * * *

Though treating ore of somewhat lower grade than during the previous years, higher extractions were obtained in the concentrator. Owing to a higher percentage of iron sulphide in the Liberty ore and also in ore from the Eureka pit, obtained from the deeper levels, the ratio of concentration was less favorable than in 1912, being 9.09 in the latter year and 6.94 in 1913. * * *

The results of the year 1913 were as follows:

Operations of Nevada Consolidated mill in 1913.

Tons of ore treated (dry)	3,139,137
Average copper assay—per cent	1.599
Percentage of extraction (copper)	68.52
Ratio of concentration	6.94
Assay value of gold—ounces	.013
Assay value of silver—do	.034
Percentage of extraction (gold)	43.87
Percentage of extraction (silver)	57.83
Average gold and silver recovered per ton in cents	12.32
Average copper in concentrates—per cent	7.61

* * * The yield for the year 1913 from all sulphide ore mined and treated and from siliceous carbonate ore delivered to the smelter has been 64,972,820 pounds of copper. The average cost per pound of copper was 9.99 cents, and deducting miscellaneous earnings, this is reduced to 9.51. The costs include all possible charges.

The Grand Prize group was operated continuously during 1913 and yielded chiefly oxidized and some sulphide lead ore containing silver and a little copper and gold. The property is opened by a tunnel 325 feet long, in which, at the 154-foot point, is an incline shaft 120 feet deep. The oxidized zone extends apparently about 200 feet in depth.

White Pine district.—The total output of the district made by six producers was 308 tons of ore, containing $196 in gold, 16,953 ounces of silver, 26,187 pounds of copper, and 209,266 pounds of lead, valued in all at $23,703, or an average value of $76.96 per ton.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY ON METAL MINING AND MINERALS IN NEVADA.

ANDERSON, ROBERT, Geology and oil prospects of the Reno region, Nevada: Bull. 381, pp. 475–489, 1910.

BAIN, H. F., A Nevada zinc deposit: Bull. 285, pp. 166–169, 1906.

BALL, S. H., Notes on the ore deposits of southwestern Nevada and eastern California: Bull 285, pp. 53–73, 1906; see also Bull. 308, 218 pp., 1907.

BANCROFT, HOWLAND, Platinum in southeastern Nevada: Bull. 430, pp. 192–199. 1910.

BECKER, G. F., A summary of the Comstock lode and the Washoe district: Second Ann. Rept., pp. 291–330, 1882.

——— Geology of the Comstock lode and the Washoe district, with atlas: Mon. 3, 422 pp., 1882.

——— Summary of the geology of the quicksilver deposits of the Pacific slope: Eighth Ann. Rept., part 2, pp. 961–985, 1889.

——— Geology and quicksilver deposits of the Pacific slope, with atlas: Mon. 13, 486 pp., 1888.

CURTIS, J. S., Silver-lead deposits of Eureka district, Nevada: Mon. 7, 200 pp., 1884.

——— Abstract of report on the mining geology of the Eureka district, Nevada: Fourth Ann. Rept., pp. 221–251, 1884.

DOLE, R. B., Exploration of salines in Silver Peak Marsh, Nevada; Bull. 530, pp. 330–345, 1913.

ECKEL, E. C., Portland-cement materials and industry in the United States, with contributions by E. F. Burchard and others: Bull. 522, p. 259, 1913.

EMMONS, W. H., Reconnaissance of some mining camps in Elko, Lander, and Eureka counties, Nev.: Bull. 408, pp. 130, 1910.

GALE, H. S., Late developments of magnesite deposits in California and Nevada: Bull. 540, pp. 483–520, 1914.

HAGUE, ARNOLD, Abstract of the report on the geology of the Eureka district, Nevada: Third Ann. Rept., pp. 237–290, 1883.

——— Geology of the Eureka district, Nevada: Mon. 20, 419 pp, 1892.

——— and IDDINGS, J. P., On the development of crystallization in the igneous rocks of Washoe, Nev., with notes on the geology of the district: Bull 17, 44 pp., 1885.

HAHN, O. H., The smelting of argentiferous lead ores in the Far West (Nev.): Mineral Resources, 1882, pp. 324–345, 1883.

HANCE, J. H., The Coaldale coal field, Esmeralda County, Nev.: Bull. 531, pp. 313–522, 1913.

HARDER, E. C., Iron ores near Dayton, Nev.: Bull. 430, pp. 240–246, 1910.

HEIKES, V. C., Dry placers in Nevada: Mineral Resources, 1912, pp. 260–261, 1913.

HILL, J. M., Notes on the economic geology of the Ramsey, Tallapoosa, and White Horse mining districts in Lyon and Washoe counties, Nev.: Bull. 470, pp. 99–108, 1911.

——— The Yellow Pine mining district, Clark County, Nev.: Bull. 540, pp. 223–274, 1914.

——— The mining districts of the western United States, with a geologic introduction by Waldemar Lindgren: Bull. 507, 309 pp., 1912.

——— Some mining districts of northeastern California and northwestern Nevada: Bull. 594. [In preparation.]

LINDGREN, WALDEMAR, Rough field notes in National Miner, Aug. 18, 1911, and also delivered before the Geological Society of Washington: Min. and Eng. World, Dec. 9, 1911, p. 1175. Republished in Mineral Resources, 1911, pt. 1, pp. 679–680, 1912.

LORD, ELIOT, Comstock mining and miners: Mon. 4, 451 pp., 1883.

MARSHALL, R. B., Results of spirit leveling in Nevada, 1897 to 1909, inclusive: Bull. 488, 38 pp., 1911.

RANSOME, F. L., Geology and ore deposits of Goldfield, Nev.; Prof. Paper 60, 258 pp., 1909.

——— The Horn Silver district, Nevada: Bull. 380, pp. 41–43, 1909.

——— Some mining districts of Humboldt County, Nev.: Bull. No. 414, 71 pp., 1909.

——— The Yerington copper district, Nevada: Bull. No. 380, pp. 99–119, 1909.

——— Round Mountain, Nevada: Bull. No. 380, pp. 44–47, 1909.

RANSOME, F. L., Preliminary account of Goldfield, Bullfrog, and other mining districts in southern Nevada, with notes on the Manhattan district, by G. H. Garrey and W. H. Emmons: Bull. 303, 98 pp., 1907.
——— EMMONS, W. H., and GARREY, G. H., Geology and ore deposits of the Bullfrog district, Nevada: Bull. No. 407, p. 130, 1910.
RUSSELL, I. C., Sketch of the geological history of Lake Lahontan: Third Ann. Rept., pp. 189–235, 1883.
SANFORD, SAMUEL, and STONE, R. W., Useful minerals of the United States: Bull. 585, pp. 115–123, 1914.
SCHRADER, F. C., A reconnaissance of the Jarbidge, Contact, and Elk Mountain mining districts, Elko County, Nev.: Bull. No. 497, pp. 162, 1912.
——— Notes on Antelope district, Nevada: Bull. 530, pp. 87–98, 1913.
——— The Rochester mining district, Nevada: Bull. 580 (in press).
SMITH, J. P., The Middle Triassic marine invertebrate faunas of North America: Prof. Paper 83, pp. 6–8, 1914.
SPURR, J. E., Ore deposits of the Silver Peak quadrangle, Nevada: Prof. Paper No. 55, 174 pp., 1906.
——— Geology of the Tonopah mining district, Nevada: Prof. Paper 42, 295 pp., 1905.
——— The ores of Goldfield, Nev.; Developments at Tonopah, Nev., during 1904: Bull. 260, pp. 132–149, 1905.
——— Peliminary report on the ore deposits of Tonopah, Nev.: Ore deposits of the Silver Peak quadrangle; Notes on the geology of the Goldfield district: Bull. 225, pp. 89–119, 1904.
——— Descriptive geology of Nevada south of the fortieth parallel and adjacent portions of California: Bull. No. 208, 229 pp., 1903.
——— The ore deposits of Tonopah, Nev. (preliminary report): Bull. 219, 31 pp., 1903.
——— Ore deposits of Tonopah and neighboring districts, Nevada: Bull. 213, pp. 81–87, 1903.
WALCOTT, C. D., Paleontology of the Eureka district: Mon. 8, 298 pp., 1884.
WEEKS, F. B., Geology and mineral resources of the Osceola mining district, White Pine County, Nev.: Bull. 340, pp. 117–133, 1908.
——— Tungsten ore in eastern Nevada: Bull. 213, p. 103, 1903.

GOLD AND SILVER.

(GENERAL REPORT.)

By H. D. McCaskey.[1]

ACKNOWLEDGMENTS.

To the thousands of men engaged in the mining and metallurgical industries, to merchants, bankers, and transportation officials of the United States and Alaska, to the Bureau of the Mint, the Post Office Department, the Bureau of Foreign and Domestic Commerce of the Department of Commerce, and to other officials, public and private, who have cooperated with the United States Geological Survey in furnishing information on the production of gold and silver, acknowledgment is most gratefully made. This cooperation is each year more freely given, and the results are correspondingly of increased value, not only to those directly concerned, but also to the public at large. To the authors of the various Survey mines reports on the production of gold, silver, copper, lead, and zinc, in the Central and Western States, and in Alaska, Messrs. B. S. Butler, A. H. Brooks, J. P. Dunlop, C. N. Gerry, V. C. Heikes, Charles W. Henderson, and Charles G. Yale, the writer is especially indebted.

PRODUCTION OF GOLD AND SILVER IN 1913.

GENERAL STATEMENT.

The recovered output of gold and silver in the United States from domestic ores and gravels in 1913 is shown in the following table in distribution by States.

Approximate distribution, by producing States and Territories, of the production of gold and silver in the United States for the calendar year 1913, in fine ounces.[2]

State or Territory.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
Alabama	443	$9,200	100	$100
Alaska	735,364	15,201,300	366,700	221,500
Arizona	198,406	4,101,400	3,912,000	2,362,800
California	979,174	20,241,300	1,421,500	858,600
Colorado	876,057	18,109,700	8,989,700	5,429,800
Georgia	645	13,300	100	100
Idaho	60,193	1,244,300	9,477,100	5,724,200
Illinois			2,300	1,400
Maryland	32	700		
Michigan			333,700	201,600
Missouri			38,900	23,500
Montana	160,647	3,320,900	12,540,300	7,574,300
Nevada	579,408	11,977,400	15,657,400	9,457,100
New Mexico	43,149	892,000	1,666,900	1,006,800
North Carolina	5,574	115,200	1,700	1,000
Oklahoma			800	500
Oregon	71,495	1,477,900	172,200	104,000
Philippine Islands	34,204	707,000	6,300	3,800
Porto Rico	50	1,100		
South Carolina	198	4,100		
South Dakota	348,988	7,214,200	172,600	104,200
Tennessee	371	7,700	109,000	65,800
Texas	11	200	429,800	259,600
Utah	172,711	3,570,300	11,282,300	6,814,500
Virginia	11	200	200	100
Washington	31,806	657,500	218,700	132,100
Wyoming	847	17,500	1,200	700
Total	4,299,784	88,884,400	66,801,500	40,348,100

[1] Valuable aid has been rendered by J. P. Dunlop in the preparation of the tables of this report and in the verification of all figures.

[2] Gold value, $20.67+ per fine ounce. Average commercial price of silver in 1913, 60.4 cents per fine ounce.

The figures in this table are also those of the Director of the Mint. They result from cooperation of the Bureau of the Mint and the United States Geological Survey, and are agreed upon after conference and adjustment between the two bureaus. They are, therefore, final for both.

The totals of this table are based on bullion deposits in the United States mints and assay offices and on returns to the Bureau of the Mint from the smelting and refining companies. The distribution is adjusted by information collected by the United States Geological Survey directly from the producing mines and tabulated for the mines reports later discussed. The data giving the total production, and in part the distribution, are obtained from records of (1) the unrefined domestic gold and silver deposited in United States mints and assay offices, (2) the domestic gold and silver in fine bars reported by private refineries, and (3) the unrefined domestic gold and silver contained in ores, matte, etc., exported for reduction. The last item is of small relative importance.

Gains and losses in the production of gold and silver in the several States and Territories, as compared with the output of 1912, are shown in the following table:

Increase (+) or decrease (−) in production of gold and silver in the United States in 1913, by States and Territories, in fine ounces.

State or Territory.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
Alabama	− 352	− $7,200	− 100	
Alaska	− 96,617	−1,997,300	− 173,000	− $110,300
Arizona	+ 15,289	+ 316,000	+ 465,500	+ 241,800
California	+ 11,287	+ 233,300	+ 36,700	+ 7,400
Colorado	− 30,549	− 631,600	+1,056,000	+ 553,300
Georgia	+ 119	+ 2,400	− 100	
Idaho	− 7,617	− 157,400	+1,614,200	+ 890,800
Illinois			+ 500	+ 300
Maryland	− 28	− 500	− 700	− 400
Michigan			− 209,800	− 132,500
Missouri			+ 8,000	+ 5,100
Montana	− 18,724	− 387,000	+ 16,300	− 124,200
Nevada	− 77,314	−1,598,300	+1,806,000	+ 942,700
New Mexico	+ 6,643	+ 137,400	+ 203,100	+ 108,800
North Carolina	− 1,970	− 40,800	− 600	− 400
Oklahoma			+ 800	+ 500
Oregon	+ 34,746	+ 718,200	+ 118,200	+ 70,800
Philippine Islands	+ 11,873	+ 245,400	+ 500	+ 200
Porto Rico	+ 50	+ 1,100		
South Carolina	− 546	− 11,300		
South Dakota	− 29,482	− 609,500	− 33,200	− 22,300
Tennessee	− 186	− 3,800	− 3,000	− 3,000
Texas	− 94	− 2,000	+ 50,000	+ 26,100
Utah	− 35,912	− 742,300	−1,794,400	− 1,223,800
Virginia	− 3	− 100	− 500	− 300
Washington	− 1,217	− 25,100	− 132,100	− 83,500
Wyoming	− 329	− 6,800	+ 900	+ 500
Increase (+) or decrease (−)	−220,933	−4,567,100	+3,034,700	+ 1,150,600

In addition to the production of gold and silver from domestic sources in 1913, the domestic smelters and refineries produced as refined bullion from foreign ore, matte, and unrefined bullion 900,720 fine ounces of gold and 50,708,690 fine ounces of silver. Of the foreign gold 279,061 ounces is credited to Mexico, 399,726 ounces to Canada (including British Columbia, the Yukon, and the Klondike), 56,009

ounces to Central America and 45,316 ounces to South America, 88 ounces to Cuba, and 120,520 ounces to all other foreign sources. Of the foreign silver 28,828,540 fine ounces is credited to Mexico, 9,206.153 ounces to all Canada, 2,232,798 ounces to Central America, and 7,67[illegible],307 ounces to South America, 18,832 ounces to Cuba, and 2,743,060 ounces to all other foreign sources.

PRICES OF SILVER.

The average monthly prices of fine silver in New York in 1913 were as follows:

Price of silver per fine ounce in 1913, by months.

January	$0.64288	August	$0.60783
February	.63056	September	.62085
March	.59312	October	.62287
April	.60875	November	.60472
May	.61812	December	.59235
June	.60485		
July	.60211	Yearly average	.60447

The average annual price of silver per fine ounce from 1865 to 1913, inclusive, has been:

Annual price of silver per fine ounce in New York, 1865–1913.

1865	$1.337	1890	$1.05
1866	1.339	1891	.99
1867	1.33	1892	.87
1868	1.326	1893	.78
1869	1.325	1894	.63
1870	1.328	1895	.65
1871	1.325	1896	.68
1872	1.322	1897	.60
1873	1.297	1898	.59
1874	1.278	1899	.60
1875	1.24	1900	.62
1876	1.16	1901	.60
1877	1.20	1902	.53
1878	1.15	1903	.54
1879	1.12	1904	.58
1880	1.15	1905	.61
1881	1.13	1906	.68
1882	1.14	1907	.66
1883	1.11	1908	.53
1884	1.11	1909	.52[illegible]
1885	1.07	1910	.54
1886	.99	1911	.53
1887	.98	1912	.615
1888	.94	1913	.604
1889	.94		

WORLD'S PRODUCTION OF GOLD.

The production of gold in the world from 1860 to 1912, inclusive, is shown in the table following.

Production of gold in the world, 1860–1912.

[The annual production from 1860 to 1872 is obtained from 5-year periods compiled by Dr. Adolph Soetbeer. From 1872 to 1912, inclusive, the estimates are those of the Bureau of the Mint.]

Calendar year.	Value.	Calendar year.	Value.	Calendar year.	Value.	Calendar year.	Value.
1860	$134,083,000	1874	$90,750,000	1888	$110,196,900	1902	$296,737,600
1861	122,989,000	1875	97,500,000	1889	123,489,200	1903	327,702,700
1862	122,989,000	1876	103,700,000	1890	118,848,700	1904	347,377,200
1863	122,989,000	1877	113,947,200	1891	130,650,000	1905	380,288,700
1864	122,989,000	1878	119,092,800	1892	146,651,500	1906	402,503,000
1865	122,989,000	1879	108,778,800	1893	157,494,800	1907	412,966,600
1866	129,614,000	1880	106,436,800	1894	181,175,600	1908	442,476,900
1867	129,614,000	1881	103,023,100	1895	198,763,600	1909	454,059,100
1868	129,614,000	1882	101,996,600	1896	202,251,600	1910	455,239,100
1869	129,614,000	1883	95,392,000	1897	236,083,700	1911	461,939,700
1870	129,614,000	1884	101,729,600	1898	286,879,700	1912	466,136,100
1871	115,577,000	1885	108,435,600	1899	306,724,100		
1872	115,577,000	1886	106,163,900	1900	254,576,300	Total.	10,349,378,600
1873	96,200,000	1887	105,774,900	1901	260,992,900		

In the following table is shown the output of gold, by countries, for the 11 years ending 1912:

World's production of gold, 1902–1912, by countries.

Country.	1902	1903	1904	1905	1906	1907
North America:						
United States	$80,000,000	$73,591,700	$80,464,700	$88,180,700	$94,373,800	$90,435,700
Canada	21,336,700	18,834,500	16,462,500	14,610,400	12,023,900	8,382,800
Mexico	10,153,100	10,677,500	12,605,300	16,107,100	18,534,700	18,681,100
Africa	39,093,700	67,998,100	87,913,900	113,254,700	135,358,000	151,984,100
Australasia	81,578,800	89,210,100	87,767,300	85,926,500	82,391,400	75,677,700
Europe:						
Russia and Finland	22,534,700	24,634,200	24,803,200	22,292,200	19,496,500	26,684,300
Austria-Hungary	2,171,300	2,245,100	2,117,300	2,457,400	2,615,400	2,484,900
Germany	62,500	70,500	64,700	66,700	80,400	66,600
Norway	2,000	2,700	.....	.....	.....	.....
Sweden	62,500	33,900	40,200	36,700	13,300	18,700
Italy	5,300	26,700	44,000	44,000	41,200	39,600
Spain and Portugal	11,500	6,700	.....	.....	.....	.....
Turkey	30,600	20,700	29,000	6,000	6,000	4,500
France	.....	.....	.....	.....	502,400	837,400
Great Britain	77,300	94,000	359,800	112,700	29,200	29,200
Servia	.....	.....	.....	.....	59,800	59,800
South America:						
Argentina	30,000	30,000	9,200	5,500	5,500	103,000
Bolivia	1,000	2,900	21,900	18,800	754,600	1,267,400
Chile	666,900	636,900	636,900	948,500		
Colombia	2,522,600	2,724,400	1,974,400	2,584,000	2,190,800	3,255,600
Ecuador	200,000	274,400	132,900	188,500	294,200	267,100
Brazil	2,099,900	2,280,400	2,043,500	2,044,600	2,403,000	2,020,700
Venezuela	433,800	300,000	300,000	171,400	25,300	22,400
Guiana:						
British	1,808,600	1,611,300	1,608,800	1,690,700	1,607,700	1,304,400
Dutch	322,000	375,900	441,600	632,500	689,200	640,000
French	2,420,200	2,101,500	1,806,400	1,859,700	1,878,900	2,360,800
Peru	2,326,100	592,600	1,329,200	516,100	829,000	514,500
Uruguay	57,800	51,500	25,000	50,000	31,700	51,900
Central America	2,001,900	1,875,300	1,252,500	1,513,400	1,910,700	2,107,800
Asia:						
Japan	1,975,800	2,891,200	2,948,500	3,072,400	2,748,900	2,773,000
China	8,731,800	7,324,700	4,500,000	4,500,000	4,500,000	4,500,000
Indo-China	.....	.....	.....	.....	.....	31,800
Chosen (Korea)	3,000,000	3,000,000	3,000,000	2,593,000	2,283,000	2,170,800
Siam	.....	.....	51,800	48,600	73,200	166,200
India, British	9,588,100	11,428,900	11,722,900	11,950,200	12,087,700	10,383,600
East Indies, British	1,027,100	1,344,800	1,485,300	1,391,200	1,448,700	1,561,300
East Indies, Dutch	474,000	1,409,600	1,414,500	1,414,500	1,254,900	2,079,900
Total	296,737,600	327,702,700	347,377,200	380,288,700	402,503,000	412,966,600

World's production of gold, 1902–1912, by countries—Continued.

Country.	1908	1909	1910	1911	1912	Total.
North America:						
United States	$94,560,000	$99,673,400	$96,269,100	$96,890,000	$93,451,500	$987,890,600
Canada	9,482,100	9,382,200	10,205,800	9,762,100	12,648,800	143,131,800
Mexico	22,371,200	23,842,900	24,910,600	24,880,100	24,500,000	207,263,600
Cuba				20,000		20,000
Africa	166,520,500	170,988,600	175,189,900	191,538,400	211,850,600	1,509,620,500
Australasia	73,327,300	71,007,900	65,470,600	60,184,200	54,509,400	827,051,200
Europe:						
Russia and Finland	28,052,200	32,381,300	35,579,600	32,151,600	22,199,000	290,808,800
Austria-Hungary	2,469,300	1,942,000	2,172,600	2,185,100	2,043,200	24,903,600
Germany	64,800	69,200	62,900	78,100	78,100	764,500
Norway			1,400			6,100
Sweden	14,500	10,100	2,000	2,000	20,300	254,200
Italy	46,500	24,200	29,600	44,800	11,000	356,900
Spain and Portugal		2,900	2,800	2,400	2,300	28,600
Turkey	2,200	500	500	500	500	101,000
France	1,147,400	1,400,600	1,707,100	1,812,100	1,812,100	9,217,100
Great Britain	16,000	21,500	39,600	39,600	27,800	846,700
Servia	59,800	150,300		251,100	251,100	831,900
South America:						
Argentina	161,300	189,900	173,100	289,000	107,300	1,103,800
Bolivia and Chile	346,300	492,400	463,600	362,500	175,000	6,795,600
Colombia	3,427,300	3,179,900	3,370,000	3,167,800	2,971,700	31,368,500
Ecuador	350,300	274,400	249,200	276,800	406,500	2,914,300
Brazil	2,196,600	2,252,900	1,954,700	3,834,500	3,570,600	26,701,400
Venezuela	24,500	280,600	340,500	364,800	623,500	2,886,800
Guiana:						
British	1,408,100	1,192,700	1,192,700	892,000	879,800	15,196,800
Dutch	663,000	621,000	792,600	523,400	407,300	6,108,500
French	2,135,500	2,143,800	2,229,100	2,229,100	3,050,600	24,195,600
Peru	514,500	514,500	455,900	492,300	492,200	8,576,900
Uruguay	91,600	91,600	91,600	70,600	111,000	724,300
Central America	3,018,800	2,630,100	4,657,400	3,360,400	3,030,400	27,358,700
Asia:						
Japan	3,321,600	3,616,900	3,903,600	4,118,600	4,467,000	35,837,500
China	8,647,300	9,352,100	3,658,100	3,314,600	3,658,900	62,687,500
Indo-China	65,600	65,600	55,000	74,700	74,700	367,400
Chosen (Korea)	3,047,500	1,993,600	4,399,100	2,889,400	2,852,600	31,229,000
Siam	327,600	327,600	56,500	56,500	56,500	1,144,500
India, British	10,598,500	10,358,600	10,718,400	11,054,100	11,055,700	120,946,700
East Indies, British	1,400,900	1,436,900	1,446,800	1,339,400	1,352,000	15,234,400
East Indies, Dutch	2,596,300	2,146,400	3,387,100	3,387,100	3,387,100	22,951,400
Total	442,476,900	454,059,100	455,239,100	461,939,700	466,136,100	4,447,426,700

PRODUCTION OF GOLD AND SILVER SINCE 1792.

According to tables published by the Director of the Mint, the total production of gold and silver in the United States from 1792 to 1913, inclusive, is as follows:

Production of gold and silver in the United States, 1792–1913, by periods, in fine ounces.

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and since by the Director of the Mint.]

Year.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
1792–1847	1,187,170	$24,537,000	309,500	$404,500
1848–1872	58,279,778	1,204,750,000	118,568,200	157,749,900
1873–1913	111,819,503	2,311,512,400	1,967,088,400	1,551,363,200
Total	171,286,461	3,540,799,400	2,085,966,100	1,709,517,600

The table following shows the quantity and value of these metals produced in the United States since 1880:

Production of gold and silver in the United States from 1880 to 1913, inclusive, in fine ounces.

Year.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
1880	1,741,500	$36,000,000	30,318,700	$34,717,000
1881	1,678,612	34,700,000	33,257,800	37,057,500
1882	1,572,187	32,500,000	36,196,900	41,105,900
1883	1,451,250	30,000,000	35,732,800	39,618,400
1884	1,489,950	30,800,000	37,743,800	41,921,300
1885	1,538,373	31,801,000	39,909,400	42,503,500
1886	1,686,788	34,869,000	39,694,000	39,482,400
1887	1,603,049	33,136,000	41,721,600	40,887,200
1888	1,604,478	33,167,500	45,792,700	43,045,100
1889	1,594,775	32,967,000	30,034,500	46,838,400
1890	1,588,877	32,845,000	54,516,300	57,242,100
1891	1,604,840	33,175,000	58,330,000	57,630,000
1892	1,597,098	33,015,000	63,500,000	55,662,500
1893	1,739,323	35,955,000	60,000,000	46,800,000
1894	1,910,813	39,500,000	49,500,000	31,422,100
1895	2,254,760	46,610,000	55,727,000	36,445,500
1896	2,558,132	53,088,000	58,834,800	39,654,000
1897	2,774,935	57,363,000	53,860,000	32,316,000
1898	3,118,398	64,463,000	54,438,000	32,118,400
1899	3,437,210	71,053,400	54,764,500	32,858,700
1900	3,829,897	79,171,000	57,647,000	35,741,100
1901	3,805,500	78,666,700	55,214,000	33,128,460
1902	3,870,000	80,000,000	55,500,000	29,415,000
1903	3,560,000	73,591,700	54,300,000	29,322,000
1904	3,892,480	80,464,700	57,682,800	33,456,000
1905	4,265,742	88,180,700	56,101,600	34,222,000
1906	4,565,333	94,373,800	56,517,900	38,256,400
1907	4,374,827	90,435,700	56,514,700	37,299,700
1908	4,574,340	94,560,000	52,440,800	28,050,600
1909	4,821,701	99,673,400	54,721,500	28,455,200
1910	4,657,018	96,269,100	57,137,900	30,854,500
1911	4,687,053	96,890,000	60,399,400	32,615,700
1912	4,520,717	93,451,500	63,766,800	39,197,500
1913	4,299,783	88,884,400	66,801,500	40,348,100
Total	98,279,739	2,031,619,600	1,730,895,000	1,300,288,800

IMPORTS AND EXPORTS.

The following table gives a summary of imports and exports of gold and silver during 1913:

Imports and exports of gold and silver during the calendar year 1913.

[Figures furnished by the Bureau of Foreign and Domestic Commerce.]

Metal.	Imports.	Exports.	Excess of	
			Imports.	Exports.
GOLD.				
Contained in domestic ore and base bullion		$602,781		$602,781
Contained in foreign ore and base bullion	$12,086,204	234	$12,085,970	
Domestic bullion, refined		46,139,054		46,139,054
Foreign bullion, refined	30,163,682	267	30,163,415	
United States coin	16,088,053	44,547,670		28,459,617
Foreign coin	5,366,893	508,604	4,858,289	
Total	63,704,832	91,798,610	47,107,674	75,201,452
Excess of exports				28,093,778
SILVER.				
Contained in domestic ore and base bullion		154,769		154,769
Contained in foreign ore and base bullion	15,887,848		15,887,848	
Domestic bullion, refined		59,293,424		59,293,424
Foreign bullion, refined	17,168,693	2,516,132	14,652,561	
United States coin	1,953,082	216,096	1,736,986	
Foreign coin	858,196	596,210	261,986	
Total	35,867,819	62,776,631	32,539,381	59,448,193
Excess of exports				26,908,812

MINES REPORT.

METHOD OF COLLECTING STATISTICS.

The first table in this report presents the final official figures of the production of gold and silver in the United States in 1913 as agreed upon by the Bureau of the Mint and the United States Geological survey. With the comparatively unimportant exceptions of domestic gold and silver contained in ores, mattes, etc., exported for reduction during the year, these figures record the actual production of gold and silver bullion from domestic ores in marketable form as metals, either refined or unrefined.

Owing to the difficulty of tracing this total gold and silver production back to its origin by States, counties, and mining districts, however, the Geological Survey attacks the problem of distribution by systematic investigation of the mine production of ores containing gold and silver during the calendar year, and of the output of the placer mines. In this way the state of the mining industry is studied in detail, and classification of output by methods of production and by kinds of ore, as well as by mining districts, is obtained. The resulting figures form the basis of the mines report.

As already stated, the Bureau of the Mint takes into account, as the basis for figures of production, statistics of gold and silver in unrefined bullion deposited in the United States mints and assay offices, in fine bars of both metals produced by private refineries, and in ores, mattes, etc., exported for treatment.

The data for the mines report of the United States Geological Survey may be classified as follows: (1) Gold and silver from placers in nuggets, dust, and bullion; (2) gold and silver in mill bullion (obtained by amalgamation, cyanidation, chlorination, etc.) from mills of mine companies treating their own ores, tailings, dumps, etc.; (3) gold and silver in base bullion, matte, etc. (by assay value), from smelters treating their own ores; and (4) gold and silver in crude ore, concentrates, old tailings, slags, etc. (by assay value), shipped to custom mills and smelters—all four of these classes of data being for material treated at the mines or shipped from them during the calendar year.

The first item is the native gold (with silver in natural alloy) produced from placer mines and sold to Government mints and assay offices, and to refineries, banks, and traders. It is difficult to obtain accurate figures for this item only in some parts of Alaska, or from transitory miners elsewhere, or from miners who report only value received for their output. The second and third items cover metal production by mining companies whose mills and smelters treat their own ores and whose products go to the mints and refineries and are covered by confidential mine reports to the Survey. The fourth item, which covers raw mine products shipped for treatment, gives rise to the main apparent discrepancies between mine and mint-refinery reports on the production of gold and silver for the same calendar year. The discrepancies are due largely to the lapse of time between the disposal by shipment of the ore as reported from the mines and its arrival and metallurgical treatment at the mill or smelters, followed by the refining of the products, an interval in

which large quantities of metals in ores reported from the mines as shipped in one year may be reported from refineries as produced in marketable form in the following year. For instance, ore shipped in November may be smelted in the following January, and the metal content would be reported from the mines for the calendar year preceding that for which it would be reported in marketable form by the smelters and refineries. The miners furnish the United States Geological Survey with confidential reports on assay values and tonnages of ore and concentrates shipped as the measure of their output, and the mine figures are reported by the Survey so far as possible in terms of recoverable metal; and the smelters and refineries report the metals eventually produced, first as unrefined and finally as refined.

In using the mines report it should be noted that tonnages and metal output given are based not on ore mined but on ore treated or sold during the year. Of course most of the ore treated or sold is also mined during the same year, but some of it is necessarily mined during the preceding year. It must not be overlooked also that the mines report aims to give the recoverable content, not the assay content, of ore treated or sold. A part of the actual recovery is, of course, made during the early part of the following year for ores treated or sold late in the year under review, but the basis of the report is essentially metal recovered at whatever time from the tonnage treated or sold during the year covered by the report. For the second and third items enumerated the recovery figures are easily had, as the ore is treated on the ground, and the metal content of the bullion, either base or unrefined, is readily known. In the third item the refining loss and in the fourth item the combined concentrating, smelting, and refining losses must be considered. In the case of the precious metals the concentrating losses may be large and must be allowed for, but the smelting and refining losses are known to be very small and in ordinary practice to be more than offset by certain gains. These gains are of small quantities of precious metals (not paid for, but actually recovered from ores of copper, lead, and zinc) and certain differences in quantity of gold and silver between actual recovery and basis of settlement—for instance, silver is usually paid for on the basis of 95 per cent of the current New York price and gold at from $19 to $20 per fine ounce. From this it is seen that producers reporting in terms of dollars only will frequently be giving figures corresponding to production below actual final output of metal, and if they erroneously report net proceeds, as they sometimes do, their figures are still further below. Other gains offsetting refining and smelting losses are the relatively small quantities of precious metals, principally gold, not regularly reported from the mines, but coming from transitory placer miners whose production escapes estimate, from stolen ore treated in improvised "assay offices," and from smelter and refinery cleanings and similar material. Although mine reports in the aggregate may appear, therefore, to give figures of gold and silver that are too high, it is known from actual practice and comparison, later discussed, that final recoveries, especially for gold, are somewhat in excess of those reported from the mines.

COMPARISON OF MINT REPORT AND MINES REPORT.

Of the two plans outlined for ascertaining the gold and silver production of the United States it may be said that the one is a measure of the mining industry and the other a measure of the metallurgical industry; the one reports the production and recoverable content of mine output and the other the metal actually recovered in marketable form. The two methods will not produce exactly corresponding results, nor should they be expected to do so. In addition to factors already noted as causing differences between the two sets of figures, it must be remembered that it is not always a simple matter for smelters to distribute their output according to the exact origin of the ore, and it is still more difficult for refiners to do so. It is therefore always possible that some ore of Canadian or Mexican origin is contributing to the output of metal thought by smelters to be of domestic origin.

The calendar year covered by both investigations is the same, but the period of mine production naturally corresponds to a period earlier than the period of actual production of marketable metal by the interval of time necessary for transporting, sampling, and treating the ore and for refining the products. This interval is practically negligible in the case of placer and mill bullion, but may be several months in the case of crude smelting ores, and especially of ores concentrated before smelting.

The figures for the mint report and the mines report for a period of years sufficiently long to compensate for overlap or lag should agree within allowable limits of error due to the complex nature of the ores and of the methods of treatment. The figures of the mines report may be expected, on the whole, to fall normally below those of the mint report for the reasons outlined.

For the last nine years the final figures for mint and mine returns have been as follows:

Production of gold and silver, 1905–1913, according to mint and to mine returns.

Years.	Mint.		Mine.	
	Gold.	Silver.	Gold.	Silver.
		Ounces.		*Ounces.*
1905	$88,180,700	56,101,600	$88,159,881	56,272,496
1906	94,373,800	56,517,900	97,219,645	57,362,455
1907	90,435,700	56,514,700	87,471,136	52,500,104
1908	94,560,000	52,440,800	91,914,891	50,878,140
1909	99,673,000	54,721,500	99,438,144	57,315,677
1910	96,269,100	57,137,900	94,933,778	57,598,509
1911	96,890,000	60,399,400	97,054,791	61,108,791
1912	93,451,500	63,766,800	92,880,467	66,041,506
1913	88,884,400	66,801,500	89,987,888	71,200,237
Total	842,718,200	524,402,100	839,060,621	530,277,915

These figures show an excess of gold, according to mint reports, for the nine years of $3,657,579, or a difference of a little over 0.4 per cent, but a deficit of silver production of 5,875,815 fine ounces, or a difference of a little more than 1.1 per cent. As figures for Alaska placers are not claimed to be as close as these, the differences

for the United States proper are even lower. It is thought these comparatively small differences can be accounted for by the explanations already given. For figures of any one year an excess of mining over smelting and refining, whether of gold and silver or of base metal ore, or both, is indicated by larger figures in the mine reports for gold or silver, or both; and opposite relations or perhaps excess of smelting and refining over mining by drawing upon stocks is suggested by the reverse figures.

UNITS OF MEASUREMENT.

In measurement of ores and concentrates the short ton of 2,000 pounds is used throughout. The price per fine ounce of precious metals (gold excepted, which is fixed by law at $20.67+ per fine ounce) is based upon the averages of daily market prices. The annual average commercial prices current for silver from 1865 to 1913, inclusive, are given elsewhere in this report.

PRODUCTION OF GOLD AND SILVER REPORTED FROM THE MINES.

The following table gives the quantity and value of recoverable gold and silver output by States, reported from the producing mines in 1913 to the United States Geological Survey. The increase or decrease of production shows results from comparison with the corresponding Survey mine figures for 1912.

Mine production of gold and silver in the United States in 1913 as reported to the United States Geological Survey, by States and Territories, in fine ounces and value.

State or Territory.	Gold.		Silver.		Increase (+) or decrease (—).	
	Quantity.	Value.	Quantity.	Value.	Gold, value.	Silver, quantity.
Alabama	536.67	$11,094	117	$71	— $5,630	— 51
Alaska	755,947.08	15,626,813	362,563	218,988	—1,519,138	— 152,623
Arizona	194,656.69	4,023,911	3,948,091	2,384,647	+ 261,701	+ 457,704
California	987,186.59	20,406,958	1,378,399	832,553	+ 693,480	+ 78,263
Colorado	877,857.06	18,146,916	9,325,255	5,632,454	— 441,646	+ 1,113,185
Georgia	730.85	15,108	75	45	+ 748	— 2
Idaho	65,043.04	1,344,559	9,989,193	6,033,473	— 36,655	+ 1,694,448
Illinois			3,541	2,139		— 1,190
Maryland, New Hampshire, and Pennsylvania						— 502
Michigan			295,173	178,285		— 233,280
Missouri			35,620	21,514		+ 182
Montana	168,994.77	3,493,432	13,819,201	8,346,797	— 131,803	+ 1,087,563
Nevada	570,589.41	11,795,130	16,090,083	9,718,410	—1,661,050	+ 1,721,020
New Mexico	42,663.17	881,926	1,631,273	985,289	+ 97,480	+ 94,572
North Carolina	6,116.92	126,448	1,812	1,095	— 39,566	— 3,042
Oklahoma			1,300	785		+ 1,300
Oregon	78,740.47	1,627,710	179,036	108,139	+ 857,669	+ 121,955
Philippines	42,007.02	868,362	13,000	7,852	+ 298,191	+ 5,879
Porto Rico	54.00	1,116	9	5	+ 1,116	+ 9
South Carolina	236.12	4,881	40	24	— 12,034	— 7
South Dakota	354,070.85	7,319,294	172,702	104,312	— 572,076	— 33,758
Tennessee	367.41	7,595	108,105	65,295	— 670	+ 18,212
Texas	16.45	340	427,553	258,242	+ 277	+ 21,486
Utah	172,467.95	3,565,229	13,084,835	7,903,240	— 700,622	— 751,068
Vermont	.14	3	105	63	+ 3	+ 105
Virginia	29.22	604	960	580	+ 386	— 22
Washington	33,682.30	696,275	331,239	200,068	+ 15,311	— 82,299
Wyoming	1,169.90	24,184	957	578	+ 1,949	+ 692
Total	4,353,164.08	89,987,888	71,200,237	43,004,943	—2,892,579	+ 5,158,731
Increase in value, silver						+$2,389,417

A decrease in the production of gold of $2,892,579 and an increase in the output of silver of 5,158,731 fine ounces, are shown by the mines reports for the United States for 1913, as compared with the figures for 1912. These changes are in the same direction as they were in 1912 when the gold production decreased $4,174,324 and the silver output increased 4,932,715 fine ounces as compared with the yield of 1911.

The principal producing States ranked as follows in 1913 in output of gold: California, Colorado, Alaska, Nevada, South Dakota, Arizona, Utah, Montana, Oregon, and Idaho. No other State besides these has produced over $1,000,000 in the last four years. The most notable increases in gold production in 1913 were $857,669 in Oregon, $693,480 in California, $298,191 in the Philippines, and $261,701 in Arizona. The heaviest decreases were $1,661,050 in Nevada, $1,519,138 in Alaska, $700,622 in Utah, $572,076 in South Dakota, and $441,646 in Colorado. Of the 23 geographic divisions given in the table as producing gold in 1913 the production increased in 12 and decreased in 11.

The principal silver-producing States ranked as follows in output for 1913: Nevada, Montana, Utah, Idaho, Colorado, Arizona, New Mexico, and California. No other State has produced 1,000,000 ounces in silver in the last three years. The largest increases in silver output in 1913 were 1,721,020 ounces in Nevada, 1,694,448 ounces in Idaho, 1,113,185 ounces in Colorado, 1,087,563 ounces in Montana, and 457,704 ounces in Arizona. The largest decreases in silver yield were 751,068 ounces in Utah and 233,280 ounces in Michigan. Of the 28 geographic divisions given as producing silver there was increased output in 16 and decreased yield in 12. Four increases and four decreases were of trifling significance, however.

MINE PRODUCTION OF GOLD AND SILVER, BY STATES.

ALASKA.

It is estimated by A. H. Brooks, of the United States Geological Survey, that the total output of gold lode mines of Alaska, from earliest mining in 1882 to the end of 1913, has been $62,626,113, and that since mining began in 1880 the Alaska placers have produced $165,480,848. The total output of silver from auriferous lode mines has been 1,096,336 fine ounces and from placers 1,710,503 fine ounces.[1]

Gold.—The gold production of Alaska in 1913 was $15,626,813, against $17,145,951 in 1912. The yield from siliceous ores was $4,814,813, against $5,002,399 in 1912, and that from copper ores was $132,000, against $153,552 in 1912. The remainder of the output was from placers and amounted to $10,680,000 in 1913, against $11,990,000 in 1912, and $12,540,000 in 1911.

From the Pacific coast belt, including southeastern Alaska and Prince William Sound, the production of gold in 1913 was $4,529,529 in 1913, against $4,904,753 in 1912, a falling off of $375,224. From the Copper River and Cook Inlet region it was $378,643, against $358,401 in 1912. From the Yukon and Kuskokwim basins it was $8,183,641, against $8,857,797 in 1912, a decrease of $674,156, and from the Seward Peninsula and northwestern Alaska it was $2,535,000, against $3,025,000, a loss of $490,000. The decreased output of gold in Alaska in 1913 was chiefly due to the dry season in the Yukon

[1] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 217, 1914.

districts, in the Iditarod-Innoko region, and on Seward Peninsula; to shortage of labor in some places; and to the approaching exhaustion of the bonanza deposits of the Fairbanks district. Shortage of auriferous gravels is not imminent, but only of those that can be mined at present high costs and under other present difficulties. New areas of placer ground available for future dredging under better transportation conditions are being discovered and the installation of dredges in the accessible portions of the Seward Peninsula has been continued.

In 1913 about 31.6 per cent of the Alaskan gold output came from lode mines, against 29 per cent in 1912 and 24 per cent in 1911. The trend is obviously toward increased relative production from these mines as compared with the placers, and with the completion of the great development work on the vast low grade deposits of southeastern Alaska the gold output from this region should greatly increase. Increase of gold yield from enlarged dredging operations may confidently be expected also, however, and future decreases for some time to come will probably be in the more primitive methods of placer mining.

The operating mines of southeastern Alaska, 7 lode gold mines, 4 placers, and 3 copper mines, produced $4,229.648 in gold in 1913, the bulk of which was from the famous Treadwell group of the Juneau region. Development of the vast gold deposits of the adjoining Alaska-Gastineau and Alaska-Juneau mines bids fair to make these, with the Alaska-Treadwell, the center of one of the great gold-mining districts of the world.

Thirty-six gold dredges were productive in Alaska in 1913, of which 31 were on the Seward Peninsula. Altogether the dredges treated about 4,100,000 cubic yards of gravel and produced about $2,200,000 in gold. It is estimated that about 700 placer mines in all were in operation and that a total of about 6,800,000 cubic yards of gravel were handled with an average recovery of $1.57 per yard, against 7,050,000 yards in 1912 with an average recovery of $1.70 per yard.

Silver.—The production of silver in Alaska in 1913 was 362,563 fine ounces, against 515,186 ounces in 1912. Of the total output 273,179 ounces came from copper ores, 58,487 ounces from placer gold, and 30,897 ounces from siliceous gold ores.

ARIZONA.

Gold.—The recoverable output of gold from Arizona mines in 1913 was $4,023,911, against $3,762,210 in 1912, an increase of $261,701. This was the largest recorded production from Arizona to date. Of the output for 1913 $30,691 came from placers, principally in Yavapai, Yuma, and Pima counties, $2,558,426 came from dry and siliceous ores, chiefly from the gold-milling ores of the San Francisco district of Mohave County and the Vulture district of Maricopa County, and $1,332,038 was derived from copper ores, mainly from the Warren (Bisbee) district of Cochise County and the Verde district of Yavapai County. Mohave County again led in gold production followed by Cochise, Maricopa, and Yavapai, in order. By the amalgamation process $302,120 in gold was produced in Arizona in 1913, against $236,345 in 1912, and by the cyanidation process, $2,007,704, against

$1,877,241 in 1912. Crude ores shipped to smelters (mostly copper ores) contained $1,362,504 in gold, against $1,386,809 in 1912, and concentrates produced $308,090.

Silver.—The recoverable production of silver of Arizona in 1913 was 3,948,091 fine ounces, against 3,490,387 ounces in 1912, and was the record output of silver to date. Of the total production 2,885,115 ounces came from copper ores, and of this Cochise County produced 1,568,630 ounces, mainly from the Warren (Bisbee) district, and Yavapai County supplied 722,894 ounces, mainly from the Verde district. Gila County produced 343,258 ounces of silver from copper ores chiefly from the Globe district. Dry and siliceous ores produced 392,413 ounces of silver in Arizona in 1913, and lead ores 498,457 ounces, both chiefly from Cochise County. Altogether Cochise County yielded 2,127,191 ounces in 1913, against 1,962,644 ounces in 1912, and led among all counties by a large margin. Yavapai County yielded 854,049 ounces, mainly from copper ores. Bullion recovered from gold and silver ores, principally by cyanidation, contained 72,899 ounces of silver in 1913, concentrates produced 393,553 ounces, and crude ores shipped direct to smelters contained 3,403,008 ounces.

CALIFORNIA.

Gold.—The mine production of gold in California in 1913 was $20,406,958, against $19,713,478 in 1912. The output from placers and gold-quartz, copper, and lead ores increased in 1913, but there was no recovery reported from zinc ores.

The deep mines of California yielded $11,570,781 in gold in 1913, of which $11,222,566 was derived from gold-quartz ores (almost wholly gold milling), $320,939 from copper ores, and $27,276 from lead ores. The gold-quartz ores produced $10,771,759 in 1912. The placers supplied $8,836,177 in 1913, of which $8,090,294 was produced by dredging (against $7,429,955 in 1912), $329,300 came from hydraulic mines, $224,045 from surface or sluicing operations, and $192,538 from drift mines in ancient river channels.

The dredges produced nearly 40 per cent of the total gold yield in 1913 and over 91 per cent of the placer output. The total dredge production of gold in California from 1899 to the end of 1913 has been $63,505,485, and during these 15 years the production has steadily increased, showing small decreases only in 1900, 1907, and 1912. Of the three great dredging fields of California, Yuba County decreased its output in 1913 by $295,742, and Butte County by $149,070, but Sacramento County increased by $825,806.

The leading counties in gold production in California in 1913 were Nevada, with $2,918,733; Amador, with $2,901,898; Sacramento, with $2,503,633; Yuba, with $2,491,505; Butte, with $2,269,849; Shasta, with $1,208,870; Calaveras, with $1,175,208; and Sierra, with $1,006,573. Of those named Yuba, Butte, and Sacramento are essentially dredging fields, Amador and Calaveras are on the Mother Lode; Shasta produces from both siliceous and copper ores; and the production of Nevada County is chiefly from gold-quartz milling ores of the Grass Valley district.

The five Mother Lode counties—Amador, Calaveras, El Dorado, Mariposa, and Tuolumne—whose output is mainly gold-quartz milling

ores, produced altogether $4,678,053 in gold in 1913, against $4,741,497 in 1912.

Silver.—The output of silver from California mines in 1913 was 1,378,399 fine ounces, an increase of 78,263 ounces over the production of 1912. The greater part of the silver yield, or 1,158,518 ounces, was derived from the smelting of crude copper, lead, and siliceous ores, and the copper ores alone contributed 833,672 ounces. The largest part of the production came, as usual, from Shasta County, whose copper ores yielded 705,634 ounces, and whose siliceous ores produced 35,295 ounces. The lead ores of California supplied 220,229 ounces in 1913, almost wholly from Inyo County. By amalgamation of siliceous (gold-quartz) ores and old tailings 66,848 ounces were recovered in 1913, and 77,788 ounces by cyanidation.

COLORADO.

Gold.—The mine output of gold in Colorado was valued at $18,146,916 in 1913, against $18,588,562 in 1912, a decrease of $441,646.

The Cripple Creek district (Teller County) produced $10,905,003 in 1913, or 60 per cent of the State yield, against $11,008,362 in 1912. The San Juan region, including Dolores, La Plata, Ouray, San Juan, and San Miguel counties, produced $4,075,529 in 1913, against $4,119,191 in 1912. Increases of $177,500 in La Plata, $134,038 in San Juan, and $4,876 in Dolores counties were recorded; but the output fell off $269,863 in San Miguel and $90,213 in Ouray. Chaffee and Summit counties also showed increase, and Boulder, Gilpin, Gunnison, Lake, Mineral, and Park counties showed decrease in 1913.

Of the total material treated, dry and siliceous ores, which constituted 79 per cent of the total tonnage treated in 1913, yielded $16,890,236, or 93 per cent of all the gold output, against $17,391,129, or nearly 94 per cent in 1912. A little over 3 per cent of the production was derived from lead ores, and a little more than 2 per cent from the placers. The placer yield was $408,540 in 1913, a decrease of $15,345, and of this Summit County produced nearly 95 per cent from 3 dredges and 4 placers.

Silver.—The recoverable output of silver from Colorado mines in 1913 was 9,325,255 fine ounces, against 8,212,070 ounces in 1912. Lake County, whose production is principally from Leadville, yielded 3,400,318 ounces in 1913, an increase of 399,921 ounces over the output of 1912, and over 36 per cent of the total State production in 1913. Increased output of silver was reported from Boulder, Chaffee, Clear Creek, Dolores, Eagle, Gunnison, Lake, La Plata, Mineral, Park, Pitkin, and San Juan counties in 1913, and decreased yield from Gilpin and San Miguel counties.

Of the total State yield, dry or siliceous ores furnished 6,270,758 fine ounces, or 67 per cent, lead ores 1,645,186 ounces, or 18 per cent, and lead-zinc and copper-lead ores the bulk of the remainder.

IDAHO.

Gold.—The recoverable output of gold from Idaho mines in 1913 was $1,344,559, against $1,381,214 in 1912. For the first time in many years the placer production exceeded that from lode mines, and this relation is true for 1913 only in Idaho and Alaska. Gold

valued at $694,053 came from 196 placers and gold valued at $650,506 from 188 deep mines in 1913. In 1912 the placers produced $632,029 and the deep mines $749,185. Nearly 81 per cent of the placer gold output in Idaho in 1913 was produced by dredging. Of the total production 51.6 per cent was derived from placers, 34.4 per cent from dry or siliceous ores, 7.7 per cent from copper ore, 5.2 per cent from lead ore, and the small remainder from lead-zinc ore. From the gold-milling ore treated, $174,927 was recovered by amalgamation and $187,915 by cyanidation. Concentrates shipped produced $88,304, and crude ore $199,360. Boise County led in production with $620,070, of which $529,893 was from placers, mainly dredge operations in the Boise Basin district, and $90,177 was from siliceous ores, chiefly in the same district. Lemhi County followed with $276,306, of which $106,714 was from placers and $158,627 from siliceous ores. Owyhee and Idaho counties also produced notably from these ores, and Custer County from copper ores.

Silver.—The recoverable output of silver from Idaho in 1913 was 9,989,139 fine ounces, the record production, against 8,294,745 ounces in 1912. This represents the notable increase of 1,694,448 ounces, more than 20 per cent in quantity, and of $932,205 in value, over the high production of 1912. The largest part of the increase was from lead-zinc and lead ores. Of the total output in 1913 lead ores produced 78 per cent, lead-zinc ores 16 per cent, and copper ores about 4 per cent. Concentrates produced from milling and separating lead and lead-zinc ores yielded 6,720,969 ounces, and crude shipping ore 3,158,355 ounces. The bulk of the State yield was from the great Coeur d'Alene silver-lead-zinc mines in Shoshone County, whose lead ores supplied 7,461,406 ounces and whose lead-zinc ores produced 1,577,117 ounces in 1913.

MARYLAND AND PENNSYLVANIA.

Silver.—There was no production of silver reported in 1913 from the copper ores of either Maryland or Pennsylvania. In the past there has been some small silver output from refining the copper recovered, principally from the New London mines of Maryland and the Cornwall iron mine of Lebanon, Pa., from the ores of which last-named mine copper sulphides have been separated and shipped.

MICHIGAN.

Silver.—The Michigan copper mines produced 295,173 fine ounces of silver in 1913, against 528,453 ounces in 1912, the decreased output being a reflection of the labor troubles of 1913, which caused a falling off in copper mining. The silver production is mainly from the electrolytic refining of the copper produced. The average recovery of silver per ton of "rock" treated in 1913 (both conglomerate and amygdaloid) was 0.04 ounce, against 0.05 ounce in 1912 and 0.04 ounce in 1911. Of the total production in 1913 Houghton County produced 253,030 ounces and Keweenaw County 42,143 ounces.

MISSOURI, ILLINOIS, AND KENTUCKY.

Silver.—The lead and zinc mines of the Central States contribute no gold and but little silver. This last is a by-product, mainly from the refining of lead from concentrates produced at the lead mines of

southeastern Missouri. The recovery is about 1 ounce per ton of concentrates saved, and only about one-sixth of the lead from argentiferous ores is desilverized. The production of silver from Missouri was 35,620 fine ounces in 1913, against 35,438 ounces in 1912, from 35,854 short tons of lead concentrates in 1913, against 31,183 tons in 1912.

In southern Illinois the silver output in 1913 was 3,541 fine ounces from 507 short tons of silver-bearing lead concentrates (from lead-zinc fluorspar ores), against 4,731 ounces from 748 tons of concentrates in 1912. The production is incidental to concentrating the fluorspar.

The small silver yield of western Kentucky is also an incidental by-product of lead concentrates obtained from lead-zinc-fluorspar ores, but there has been no output of silver from this source in the last three years.

MONTANA.

Gold.—The recoverable output of gold from Montana mines in 1913 was $3,493,432, against $3,625,235 in 1912. The gold production of Montana has shown small but steady decrease for several years. The production of gold by amalgamation in 1913 was $48,459 and by cyanidation was $758,323, and concentrates and crude ore shipped to smelters produced $615,909 and $1,269,739, respectively. The placer production was $801,002, against $806,419 in 1912, of which $691,651 came from Madison County in 1913, chiefly from dredging operations in the Alder Gulch district. This county again in 1913 led in total gold production, chiefly from placer output, and was followed by Silver Bow County, whose output was mainly from the copper ores of Butte, and by Fergus, Broadwater, Blaine, and Deer Lodge counties, whose production was chiefly from dry or siliceous gold ores.

Silver.—The recoverable production of silver from Montana ores sold or treated in 1913 was 13,819,201 fine ounces, against 12,731,638 ounces in 1912. The copper ores alone yielded 10,311,807 ounces (against 10,655,055 ounces in 1912), and of this Silver Bow County (Butte) produced 10,148,025 ounces in 1913. The lead-zinc ores, almost wholly, and the zinc ores, wholly, from Butte, produced 1,658,286 ounces, against 402,679 ounces in 1912, the increase being mainly due to the new and highly successful operations of the Butte zinc-lead mines. The dry or siliceous ores, chiefly from Granite and Silver Bow counties, yielded 1,335,602 ounces, and the lead ores, mainly from Cascade and Jefferson counties, 493,326 ounces. In county output Silver Bow was predominant, with a total production of 12,211,725 ounces, against 11,352,106 ounces in 1912.

NEVADA.

Gold.—The recoverable output of gold from Nevada mines and mills in 1913 was $11,795,130, a decrease of $1,661,050 from the production of $13,456,180 in 1912. The gold yield of Esmeralda County, the bulk of which is from the Goldfield district, decreased from $7,014,559 in 1912 to $5,721,077 in 1913. The decrease at Goldfield alone was $1,220,328 in 1913, following similar large decreases in 1912 and 1911. The ores in this great camp are in general of less profitable grade than formerly. The production of Nye County, of which Tonopah is the principal camp, increased by

$413,864 in 1913, and the output of Tonopah alone increased from $2,223,878 to $2,613,843 in 1913. Much smaller increases were made in Clark, Mineral, Washoe, and Lander counties, and decreases in gold output were recorded from all other counties. Placer gold, amounting in all to $305,442, was produced in Nevada in 1913, chiefly in Nye County, but also in Lander, Humboldt, and six other counties. The principal placer output was from Manhattan and Round Mountain in Nye County and from Battle Mountain in Lander County. By far the greater part of the gold production of Nevada continues to come from cyanidation and amalgamation of dry or siliceous gold and silver ores, mainly from Goldfield and Tonopah, but also to smaller degree from Storey (Comstock district), Churchill, Humboldt, and other counties. Copper ores especially from White Pine County (Ely district) and Esmeralda (Goldfield) also supply notable quantities of gold. In county production of gold from all sources Esmeralda led in 1913, followed by Nye, Storey, White Pine, Churchill, and Humboldt, in order named.

Silver.—The production of silver from Nevada mines in 1913 was 16,090,083 fine ounces, an increase of 1,721,020 ounces from the high output of 14,369,093 ounces in 1912 and a continuance of the steadily augmented production for several years past. Nye County was again in the lead, with 11,634,033 ounces, of which the great Tonopah camp produced 11,563,437 ounces, almost entirely from siliceous silver-gold ores. Churchill County followed with 1,383,257 ounces, all from dry or siliceous ores and mainly from Fairview and Wonder districts. Humboldt County produced 757,505 ounces, also chiefly from dry or siliceous ores, and mainly from Rochester district. Storey County produced 729,972 ounces, from the same class of ores mined on the Comstock lode, and Lincoln County produced 475,105 ounces from siliceous, lead, and mixed ores, mostly from Pioche. In all, dry or siliceous ores supplied 15,245,541 ounces from Nevada in 1913, and the small remainder of the total silver output came from lead, copper, and mixed ores.

NEW MEXICO.

Gold.—The recoverable yield of gold from the ore output of New Mexico in 1913 was $881,926, against $784,446 in 1912. Socorro County alone produced $623,856, or nearly 71 per cent of the State yield, against $525,629 in 1912, almost wholly from siliceous ores at Mogollon. There was increased gold output from Lincoln, Luna, Otero, Santa Fe, and Taos counties also in 1912. Altogether the dry or siliceous ores supplied $761,535 in gold from New Mexico, against $609,884 in 1912. Copper ores furnished $97,103, chiefly from Lordsburg, Grant County, and San Pedro, Santa Fe County. Lead ores supplied $14,634 in gold in 1913, and the placers only $7,861.

Silver.—The recoverable output of silver from ores sold or treated from New Mexican mines in 1913 was 1,631,273 fine ounces, against 1,536,701 ounces in 1912. Socorro County produced 1,347,160 ounces in 1913, or 83 per cent of the total State yield, against 1,126,429 ounces in 1912, chiefly from siliceous ores of the Mogollon district. Grant County supplied 206,215 ounces, or 13 per cent, chiefly from the Lordsburg district. The Chino copper ores of Grant County, produced and milled in large quantities, are of exceptionally low

silver tenor, but copper ores, chiefly from this county, supplied a total of 197,574 ounces of silver from New Mexico in 1913. Dry or siliceous ores, mainly from Socorro County, furnished 1,348,514 ounces from New Mexico in 1913, against 1,141,786 ounces in 1912. Lead ores produced 68,923 ounces and lead-zinc ores 11,520 ounces in 1913.

OREGON.

Gold.—The recoverable output of gold from Oregon ores sold or treated in 1913 was $1,627,710, an increase of $857,669 over the production of 1912. The State therefore more than doubled its gold output in 1913. The yield is almost wholly from siliceous ore and placer gravels. Baker County led in gold output, as usual, with a production of $1,373,480, from both ores and gravels, or an increase of $889,439 over the yield of 1912. The placer mines of Oregon yielded $450,628 in 1913, against $189,096 in 1912, the increase being due to success in dredging operations. From siliceous ores and old tailings $573,140 was recovered by amalgamation and $250,952 by cyanidation.

Silver.—The production of silver in Oregon in 1913 was 179,036 fine ounces, against 57,081 ounces in 1912. The increase was mainly from siliceous ores, from which Grant County produced 91,588 ounces in 1913 and Baker County 74,907 ounces. Baker County also produced 4,275 ounces from refining of placer gold bullion.

SOUTH DAKOTA.

The total value of the production of gold of South Dakota from 1876 to the end of 1913 is given by C. W. Henderson, of the United States Geological Survey, as $177,954,132. The total output of silver for the same period was 5,656,027 fine ounces, valued at $4,115,991.[1]

Gold.—The output of gold from South Dakota mines in 1913 was $7,319,294, a decrease of $572,076 from the record production of $7,891,370 in 1912. The present yield of gold in South Dakota is almost wholly from siliceous milling ores, and the bulk of this is low-grade and treated both by amalgamation and cyanidation. The great Homestake mines and mills of Lawrence County were operated continuously and made the bulk of the output. The ore milled aggregated 1,540,961 short tons, with an average recovery value of $4.015 per ton, against 1,528,923 tons in 1912, with an average recovery of $4.317 per ton.

Silver.—The output of silver, derived mainly from refining the gold-mill bullion produced, was 172,702 fine ounces in 1913, against 206,460 ounces in 1912.

SOUTHERN APPALACHIAN STATES.

Gold.—The combined production of gold from the mines of Alabama, Georgia, North Carolina, South Carolina, Tennessee, and Virginia in 1913 was $165,733, against $222,496 in 1912. North Carolina again maintained the lead with an output of $126,448, followed by Georgia and Alabama, with $15,108 and $11,094, respectively. The production of gold of all three States and of South Carolina has

[1] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 42, 1914.

considerably decreased in recent years. The output is almost wholly from gold-quartz ores and from placers in the ratio of nearly 10 to 1. Tennessee contributed the bulk of the small yield from copper ores.

Silver.—The output of silver of the southern Appalachian States was 111,214 fine ounces in 1913, against 96,523 ounces in 1912. Of the total yield, Tennessee contributed 108,105 ounces, from the copper ores of the Ducktown district.

TEXAS.

Gold.—The total output of gold from Texas from 1885 to the end of 1913 is given by Henderson [1] as $41,384. The gold production of Texas is merely nominal and a by-product, being $340 in 1913, against $63 in 1912.

Silver.—The total production of silver from Texas from 1885 to the end of 1913 (practically the entire State output to date) is given by Henderson [1] as 11,211,592 fine ounces, the bulk of it from the Presidio mine. The recoverable output of silver from Texas in 1913 was 427,553 fine ounces, against 406,067 ounces in 1912 and was, as usual, chiefly from the oxidized milling ores of the Presidio mine of the Shafter district of Presidio County.

UTAH.

Gold. The total output of gold in Utah from 1864 to the end of 1913 is given by Heikes [2] as $79,314,774. The production by years, with brief notes on the history, is given in the report cited.

The production of gold in Utah in 1913 was $3,565,229, a decrease of $700,622 from the output of 1912. The largest production was from Salt Lake County, which made an output of $1,777,214, against $1,788,730 in 1912. The Bingham district alone, with its enormous output of copper ores and important yield of other ores, produced $1,774,815 in gold in 1913, against $1,785,532 in 1912. The Tintic district, lying partly in Juab and partly in Utah counties, supplied $1,412,462 in 1913, or nearly 40 per cent of the total State yield, against $1,900,731 in 1912, chiefly from dry and siliceous, copper, and lead ores. Tooele County holds the State record for the largest total production of gold for the last 24 years, principally from the Camp Floyd or Mercur district, and from siliceous and base ores treated by cyanidation; but in 1913 the Mercur mine, supplying most of this ore, was abandoned, and the mill was dismantled. The Mercur district produced $185,181 in gold in 1913, against $421,245 in 1912. Milling amalgamation was practiced in Beaver, Box Elder, and Grand counties, and cyanidation in Juab, Piute, Salt Lake, and Tooele counties, and both processes produced $271,161 in gold in 1913 from the treatment of 75,922 tons of ore and 7,125 tons of old tailings, against $440,073 from 171,117 tons of ore and 250 tons of old tailings in 1912. The total average recovery from ore and tailings was $3.88 per ton in 1913, against $2.57 in 1912. The recovery by amalgamation averaged $6.45 per ton treated in 1913, against

[1] Henderson, C. W., Gold, silver, copper, lead, and zinc in Texas in 1913 (mines report): U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 441, 1914.

[2] Heikes, V. C., Gold, silver, copper, lead, and zinc in Utah in 1913 (mines report): U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 366, 1914.

$5.20 in 1912, and that by cyanidation $3.52 per ton, against $2.56 in 1912. Of the total gold production of Utah, $613,941, against $762,438 in 1912, was derived from the smelting of copper concentrates (principally from the Bingham or West Mountain district); but lead concentrates also produced $177,917 in 1913, against $142,990 in 1912. Placer gold was produced in Garfield, Grand, San Juan, and Uinta counties to the amount of $1,920, against $5,680 in 1912.

Silver.—The total silver production of Utah from 1864 to the end of 1913, as given by Heikes,[1] has been 315,820,236 fine ounces. Details of output by years are given in the report cited.

The output of silver in Utah in 1913 was 13,084,835 fine ounces, a decrease of 751,068 ounces from the production of 13,835,903 ounces in 1912. Juab County (mainly from dry or siliceous copper and lead ores) produced 5,600,617 ounces in 1913, against 6,638,425 ounces in 1912; but Utah County (chiefly from dry and lead ores) supplied only 265,850 ounces, against 531,478 ounces in 1912. The Tintic district, lying partly in each county, but chiefly in Juab, decreased its production from 7,073,104 ounces in 1912 to 5,829,484 ounces in 1913. Summit and Wasatch counties, embracing the Park City region, produced 3,717,556 ounces, chiefly from lead and lead-zinc ores, an increase of 74,807 ounces over the output of 1912. Salt Lake County produced 2,504,021 ounces in 1913, against 2,218,822 ounces in 1912, of which the Bingham (West Mountain) district supplied 2,408,692 ounces in 1913, against 2,028,496 ounces in 1912, predominantly from lead and copper ores in nearly equal proportion. Of the total silver production of Utah, chiefly the result of smelting, 2,177,101 ounces came from lead concentrates, 6,241,585 ounces from crude lead ores, 1,988,922 ounces from crude copper ores, and 1,769,019 ounces from crude dry or siliceous ores. The production decreased from lead concentrates and from crude copper and dry or siliceous ores, but increased from crude lead ores smelted.

WASHINGTON.

The total output of gold in the State of Washington, from earliest mining to the end of 1913, is given by C. N. Gerry, of the United States Geological Survey, as $25,430,121, and the total production of silver as 5,915,301 fine ounces.[2]

Gold.—The mine production of recoverable gold in Washington in 1913 was $696,275, against $680,964 in 1912. More than 77 per cent was produced from crude ore shipped, and about 22 per cent was yielded as gold-mill bullion. The output was almost wholly from siliceous ores, and the great bulk of it came, as usual, from the Republic district of Ferry County.

Silver.—The recoverable silver production of Washington mines in 1913 was 331,239 fine ounces, against 413,538 ounces in 1912. Crude ore shipped to smelters supplied 263,955 ounces, concentrates 41,308 ounces, and mill bullion 25,907 ounces. Dry or siliceous milling and shipping ores produced nearly 187,000 ounces, of which 162,494 ounces came from Ferry County, and copper ores supplied over 140,000 ounces, almost wholly from Stevens County.

---

[1] Op. cit., p. 366.
[2] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 790, 1914.

WYOMING.

The total production of gold in Wyoming, from 1867 to the end of 1913 is given by C. W. Henderson, of the United States Geological Survey, as $1,191,178, and the output of silver for the same period as 58,680 fine ounces, valued at $40,303.[1]

Gold.—The production of gold from Wyoming mines in 1913 was $24,184, against $22,235 in 1912. Of this output $22,777 came from siliceous ores in 1913 and $1,407 from placers. The principal production was again from the Atlantic City or South Pass district of Fremont County.

Silver.—The silver output of Wyoming in 1913 was 957 ounces, against 265 ounces in 1912. The production was chiefly from copper ores of the Hartville district of Platte County.

PHILIPPINE ISLANDS.

Gold.—The gold production of the Philippines in 1913 was $868,362,[2] against $570,212 in 1912 and $189,953 in 1911. The output is almost wholly from the milling, amalgamating, and cyaniding of gold-quartz ores and from placers. About $420,000 came from these ores treated on the island of Masbate, where the Colorado mine and mill has been especially productive, and about $322,000 came from dredging the placers of Ambos Camarines, on the Pacific coast of southeastern Luzon. The notable increase in Philippine production has been mainly from these two sources, and they have stimulated other gold mining operations in the islands.

Silver.—Approximately 10,850 fine ounces of silver was produced from the refining of gold-mill and placer bullion of the Philippines in 1913. The production was 7,121 ounces in 1912 and 3,383 ounces in 1911.

NUMBER OF PRODUCING MINES.

The following table indicates the number of mines producing gold and silver in 1913, divided into placers and deep mines. The placers are those in which gold, the silver in natural alloy with the gold, and in a few instances platinum are recovered from gravels and sands, whether by hand-washing, sluicing, hydraulicking, drifting (in frozen ground or ancient buried river channels), or dredging. The deep mines are those producing gold and silver mainly from underground workings, including those whose ores are valuable chiefly for copper, lead, or zinc, but which contribute precious metals as by-products. In addition to the producing mines here enumerated, many mines were being prospected and developed without making an output in 1913, and annual assessment work (required by law to hold claims not patented) was done on a very much greater number of new or old, worked-out, or indefinitely idle properties, once productive or otherwise, and of mere mining claims, which have not yet become "mines."

The enumeration of placer mines is less satisfactory than that of deep mines, because some of the operations are only temporary and because the production is frequently by transitory miners not regu-

[1] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 50, 1914.
[2] Bur. Science Press Bull. 25, Manila, Apr. 24, 1914.

larly working placer ground. The unit, so far as possible, is, however, as for deep mines, not the operator, but the mining claim, or group of claims.

Number of producing mines in 1913, by States and Territories.[a]

State or Territory.	Number of mines.		
	Placer.	Deep.	Total.
Alabama		4	4
Alaska	700	37	737
Arizona	36	402	438
California	386	410	796
Colorado	29	829	858
Georgia	28	11	39
Idaho	196	188	384
Illinois [b]		2	2
Maryland and Pennsylvania		1	1
Michigan [b]		7	7
Missouri [b]		4	4
Montana	128	430	558
Nevada	64	722	786
New Mexico	20	108	128
North Carolina	17	7	24
Oregon	128	45	173
South Carolina	4	2	6
South Dakota	10	20	30
Tennessee [c]		2	2
Texas		5	5
Utah	7	210	217
Vermont		2	2
Virginia and New York [c]		3	3
Washington	12	45	57
Wyoming	9	6	15
Total	1,774	3,502	5,276

[a] Philippines and Porto Rico not included.
[b] Number of mines contributing to silver production in 1912.
[c] Number of mines contributing to gold and silver production in 1913.

The table shows the number and distribution of mines producing gold and silver in the United States and Alaska. With the exception of (1) some of the Michigan copper mines, (2) all zinc mines in the Eastern and Central States and a few in the far West, and (3) all lead mines of the Central States (except a few in Illinois and southeastern Missouri), practically all mines producing copper, lead, and zinc in the United States and Alaska yield gold and silver also. The table, therefore, with these exceptions, is a table of mines producing gold, silver, copper, lead, and zinc in the United States. It also includes certain mines producing oxidized manganese-iron fluxing ores of Colorado, Utah, and elsewhere, whose ores contain small quantities of precious metals, especially silver, and are sold to western smelters as flux.

Comparisons with the corresponding figures for 1912 show a net total decrease of 335 producing mines in 1913, following a decrease of 88 in 1912. The number of placers decreased by 270 (following a decrease of 102 in 1912), and the number of deep mines decreased by 65 (following an increase of 14 in 1912).

For the last 8 years the number of producing mines has been as follows.

Number of mines producing gold and silver, 1906–1913.

Year.	Placer.	Deep.	Total.
1906	2,316	2,114	4,430
1907	2,586	2,604	5,190
1908	2,599	2,864	5,463
1909	2,187	3,183	5,370
1910	2,026	3,299	5,325
1911	2,146	3,553	5,699
1912	2,044	3,567	5,611
1913	1,774	3,502	5,276
Average	2,209	3,086	5,295

The figures show that fewer placer mines and more deep mines have been reported productive in 1913 than the average for the period. The enumeration of placer mines presents certain difficulties, as noted above, and it has been especially difficult in Alaska in earlier years.

In Alaska the estimate of producing placer mines was 720 in 1912 and 700 in 1913, and there were 32 deep mines productive in 1912 and 37 in 1913. In Arizona the number of placer mines decreased from 51 to 36 and the deep mines increased from 394 to 402. In California there were 386 placers and 410 deep mines productive in 1913 against 509 placers and 532 deep mines in 1912, a total decrease of 245 producing mines in this State, which led in total number of producers in 1912 but yielded first place to Colorado in 1913. In Colorado the number of producing placers decreased from 33 to 29 and the number of deep mines from 856 to 829. In Idaho there were 196 placers and 188 deep mines producing in 1913, against 235 placers and 173 deep mines in 1912. In Montana the number of placers again decreased from 152 to 128 in 1913, and the number of deep mines decreased from 452 to 430. In Nevada there were 64 producing placers in 1913 and 722 deep mines, against 63 and 641 in 1912. In New Mexico the placers decreased from 26 to 20 and the deep mines from 119 to 108. In Oregon there were 128 placers and 45 deep mines producing in 1913 against 156 and 54 in 1912. In South Dakota, Utah, Wyoming, and Washington there was little change for 1913.

In total number of operating mines Colorado led with 858, followed by California with 796, Nevada with 786, and Alaska with 737. In number of placers Alaska led with 700, followed by California with 386, Idaho with 196, and Montana and Oregon with 128 each. In deep mines Colorado led with 829, followed by Nevada with 722, Montana with 430, California with 410, and Arizona with 402.

ORE PRODUCTION, CLASSIFICATION, AND AVERAGE VALUES.

The best index of deep mining is, of course, the tonnage, content, and value of ore mined, rather than the number of mines or of operators. In the next following table is given the ore production, by classes of ore and by States and Territories, of mines producing gold and silver and the average extraction value of precious metals per ton.

The classification adopted is necessarily arbitrary in part. An ore is generally understood to be worked at a profit for one or more metals. The complex nature of western ores, especially, and the gradations from one well-recognized class to another render essential some fixed measures for the terminology used. The dry or siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and precious metal bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The distinction between gold and silver ores is not here made. The total number of silver mines and the total production of true silver ores are both relatively very small. The copper ores include those containing over 2½ per cent of copper, or less than this in the cases of the great disseminated copper deposits of the West and of the Lake Superior ores; in general the lead ores are those containing 4½ per cent or more of lead, and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious metal content; but ores of lower grades in lead and especially in zinc are treated profitably in some places and of course they are then classified as lead or zinc ores, as the case may be. The mixed ores are combinations of the ones enumerated.

Ore production in short tons and average extraction value of gold and silver per ton in 1913, by States and Territories.[a]

State or Territory.	Dry or siliceous ores.		Copper ores.		Lead ores.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama and Georgia	6,682	$2.65				
Alaska	1,614,506	2.99	135,756	$2.19		
Arizona	297,288	9.40	7,553,935	.41	28,551	$12.24
California	2,031,429	5.61	448,439	1.84	14,267	11.24
Colorado	2,161,458	9.57	16,555	17.65	205,774	7.53
Idaho	60,325	8.09	143,865	2.46	1,598,344	2.99
Michigan [b]			1,770,000	.10		
Montana	284,488	9.58	5,335,851	1.29	27,270	12.53
Nevada	1,616,826	12.23	3,698,255	.26	18,976	13.12
New Mexico	154,607	10.19	2,006,014	.11	7,762	7.25
North Carolina [c]	11,186	10.83				
Oklahoma	29	27.07				
Oregon	155,704	8.21	122	17.71	75	20.01
South Carolina	1,010	4.64				
South Dakota	1,899,139	3.91			28	7.82
Tennessee [c]			652,253	.11		
Texas	21,576	11.46	314	18.58	12	80.16
Utah	238,901	7.97	9,070,740	.38	662,200	7.94
Vermont			95	.69		
Virginia [c]	5	21.40	802	1.34		
Washington	98,307	8.15	16,733	5.26	645	3.99
Wyoming	3,272	6.98	964	.52		
Total, 1913	10,656,738	7.15	30,850,693	.54	2,563,904	4.98
Percentage of tonnage	23.29		67.43		5.60	
Total, 1912	10,584,777	7.40	26,761,390	.63	2,388,598	4.85
Percentage of tonnage	25.76		65.12		5.82	

[a] Illinois, Missouri, the Philippines, and Porto Rico not included; crude ore tonnage, containing precious metals not known.
[b] Includes only copper ore yielding precious metals.
[c] Lead and zinc ores yielded no precious metals.

Ore production in short tons and average extraction value of gold and silver per ton in 1913, by States and Territories—Continued.

State or Territory.	Zinc ores.		Copper-lead and copper-lead-zinc ores.		Lead-zinc ores.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Alabama and Georgia							6,682
Alaska							1,750,262
Arizona	14,554	$2.19	7,834	$3.88	29,700	$3.23	7,931,862
California	1,823						2,495,958
Colorado	141,295	.10	6,417	51.73	203,367	2.47	2,734,866
Idaho	2,978	.57			646,080	1.55	2,451,592
Michigan [a]							1,770,000
Montana	3,840	2.87	1,054	8.98	307,615	3.44	5,960,118
Nevada	10,208	.25	6,197	18.03	16,749	6.36	5,367,211
New Mexico	40,439		103	29.86	8,735	.86	2,217,660
North Carolina [b]	88						11,274
Oklahoma							29
Oregon							155,901
South Carolina							1,010
South Dakota							1,899,167
Tennessee [b]							652,253
Texas					3,172	1.45	25,074
Utah	16,322	.53	2,794	23.28	211,609	3.60	10,202,566
Vermont							95
Virginia [b]							807
Washington							115,685
Wyoming							4,236
Total, 1913	231,547	.31	24,399	22.61	1,427,027	2.48	45,754,308
Percentage of tonnage	0.51		0.05		3.12		100.00
Total, 1912	377,737	1.35	14,614	30.80	967,690	2.05	41,094,806
Percentage of tonnage	0.92		0.03		2.35		100.00

[a] Includes only copper ore yielding precious metals.
[b] Lead and zinc ores yielded no precious metals.

The total quantity of ore sold or treated in 1913 and producing gold and silver was 45,754,308 short tons, against 41,094,806 tons in 1912, 35,522,890 tons in 1911, and 31,717,912 tons in 1910.

Utah led in total output of ore producing precious metals, with 10,202,566 tons, followed by Arizona with 7,931,862 tons, Montana with 5,960,118 tons, and Nevada with 5,367,211 tons, the greater part of each of these vast tonnages being of copper ores with relatively small gold and silver content.

The total production of dry or siliceous ores increased from 10,584,777 tons in 1912 to 10,656,738 tons in 1913, but the percentage of the total of this class of ore decreased from 25.76 per cent in 1912 to 23.29 per cent in 1913. The average precious metal value decreased also from $7.40 to $7.15 per ton. These decreases in percentage and value are in line with those of 1912 and 1911 and indicate a slow but steady downward movement in relative importance of the tonnage and value of these ores.

Of the total output of dry and siliceous ores the bulk were gold-silver ores, but 1,253,116 short tons were true silver ores (against an output of 848,574 tons of silver ores in 1912). In output of silver ores Nevada led with 697,775 tons, against 476,725 tons in 1912, followed by Colorado with 274,116 tons, against 158,429 tons in 1912, New Mexico with 117,098 tons, against 110,127 tons in 1912, and Utah with 73,294 tons, against 81,234 tons in 1912. Arizona also produced 26,330 tons in 1913, Oregon 23,620 tons, and Texas 21,576 tons.

The quantity of copper ores treated increased from 21,384,408 tons in 1911 to 26,761,390 tons in 1912, and to 30,850,693 tons in 1913. The average precious metal values per ton have, however, decreased from $0.67 in 1911 to $0.63 in 1912 and to $0.54 in 1913. These figures are all in harmony with the recent increase in output of the vast tonnages of low-grade copper ores, from 60.2 per cent of the total tonnage in 1911 to 65.12 per cent in 1912 and to 67.43 per cent in 1913.

The production of argentiferous lead ores also increased again from 2,388,598 tons in 1912 to 2,563,904 tons in 1913, and the relative proportion of these ores again decreased from 5.82 per cent of the total in 1912 to 5.60 per cent in 1913. The average precious metal value of the lead ores increased again, also, from $4.85 per ton in 1912 to $4.98 in 1913.

The production of gold and silver bearing zinc ores decreased again from 377,737 tons in 1912 to 231,547 tons in 1913, and the output declined from 0.92 to 0.51 per cent of the total, and the average precious metal content from $1.35 to $0.31 per ton.

The output of copper-lead and copper-lead-zinc ores increased from 14,614 to 24,399 tons, and the production from 0.03 to 0.05 per cent of the total of all classes of ores, but the average gold and silver content per ton declined from $30.80 to $22.61.

The production of lead-zinc ores increased from 924,478 tons in 1911 to 967,690 tons in 1912 and to 1,427,027 tons in 1913, and the average precious metal recovery from these ores also increased from $1.80 per ton in 1911 to $2.05 in 1912 and to $2.48 in 1913. The output decreased from 2.60 per cent in 1911 to 2.35 per cent in 1912, but increased to 3.12 per cent in 1913.

The production of dry and siliceous ores decreased from 1,761,814 tons in 1912 to 1,614,506 tons in 1913 in Alaska, from 2,225,429 tons to 2,031,429 tons in California, and from 1,901,459 tons to 1,899,139 tons in South Dakota, but increased from 1,966,300 tons to 2,161,458 tons in Colorado and from 1,400,728 tons to 1,616,826 tons in Nevada. The great output of this class of ore is notable from Colorado, California, South Dakota, Nevada, and Alaska (in order named for 1913), and is mainly from the well-known Cripple Creek, Mother Lode and Grass Valley, Homestake, Goldfield and Tonopah, and Treadwell mines, respectively, in these States.

The production of copper ores increased in Arizona from 6,542,154 tons in 1912 to 7,553,935 tons in 1913, in Montana from 5,094,432 tons to 5,335,851 tons, in Nevada from 3,276,169 tons to 3,698,255 tons, in New Mexico from 1,195,683 tons to 2,006,014 tons, in Tennessee from 603,229 tons to 652,253 tons, and in Utah from 6,670,845 tons to 9,070,740 tons; and the tonnage of copper ores from which silver was recovered decreased in Michigan from 2,500,000 tons in 1912 to 1,770,000 tons in 1913. The great output from Utah, Nevada, New Mexico, and in part from Arizona is largely from disseminated deposits, that of Butte (Montana) is from fissure deposits, and that of Michigan from the amygdaloid and conglomerate deposits of the Keweenaw district.

The output of precious metal-bearing lead ores increased from 182,745 to 205,774 tons in Colorado, from 1,597,661 to 1,598,344 tons in Idaho, and from 498,401 to 662,200 tons in Utah in 1913, and there was no notable decrease in production of this class of ore. The out-

put of argentiferous zinc ores decreased from 177,946 to 141,295 tons in Colorado. The yield of gold and silver bearing lead-zinc ores decreased from 229,107 to 203,367 tons in Colorado and from 216,764 to 211,609 tons in Utah, but increased from 480,126 to 646,080 tons in Idaho. The production of these ores in Montana for the two years is not comparable, owing to changes in the Survey classification of Montana ores for 1913; but the output for that State made a large increase for the year to 307,615 short tons.

The average extraction value of precious metals per ton of dry or siliceous ores increased in Alaska from $2.85 in 1912 to $2.99 in 1913, and in California from $4.95 to $5.61, but decreased in Colorado from $10.53 to $9.57, in Nevada from $14.74 to $12.23, in South Dakota from $4.21 to $3.91, and in Utah from $9.78 to $7.97.

The average extraction value of gold and silver per ton in copper ores increased from $0.18 to $0.26 in Nevada, and from $0.105 to $0.11 in Tennessee, remained at $0.41 in Arizona, and decreased from $1.91 to $1.84 in California, from $0.211 to $0.10 in Michigan (silver only), from $1.42 to $1.29 in Montana, from $0.275 to $0.11 in New Mexico, and from $0.56 to $0.38 in Utah. The value in lead ores increased from $2.78 to $2.99 in Idaho, but decreased from $8.67 to $7.94 in Utah, a continuation of like changes for 1912. In lead-zinc ores the average extraction value of gold and silver per ton increased from $2.17 to $2.47 in Colorado, and from $0.68 to $1.55 in Idaho, but decreased from $4.48 to $3.60 in Utah. The average value for Montana ores of this class was $3.44 in 1913.

AVERAGE TENOR OF SILVER IN ORES, BY MINING DISTRICTS.

In the general Survey report on gold and silver by the writer for 1911 the results were given of a brief study of the tenor of silver in ores by mining districts. A few copies of that report are still available for distribution.

The bulk of the silver production, as shown, is from more widely distributed sources than that of gold, the placers and mixed ores playing little part, but the dry or siliceous silver, silver-gold, and gold-silver ores, the copper ores, and the lead ores contributing more equally in the product. The high tenor of many dry or siliceous and lead ores (with the notable exception of the lead ores of the Cœur d'Alene) are shown, as well as the high tenor of silver in the copper ores in the Chitina region, Alaska, and the Leadville, Tintic, and Chewelah districts in the United States. The low silver content of the Clifton, Ray, and Ely copper ores, and especially of the Santa Rita (Chino) copper ores, is also notable.

DISTRIBUTION OF GOLD PRODUCTION OF 1913, BY SOURCES.

As shown by the following table the great bulk of the domestic gold output is from dry or siliceous ores—normally gold-quartz and gold-silver quartzose ores—and from placers, over 91 per cent of the total gold production coming from these sources alone. The total contribution of gold derived from the great copper, lead, and zinc mines of the country is therefore relatively small, notwithstanding their recent enormous development and tonnage. The changes in relative output from the various sources given in the table have been unimportant in the last four years. It is interesting to note, however,

the gradual increase in placer production from 23.76 per cent in 1910, to 24.17 per cent in 1911, to 24.94 per cent in 1912, and to 24.96 per cent in 1913; also corresponding decreases in output from dry or siliceous ores from 68.91 per cent in 1910 to 68.52 per cent in 1911, to 67.29 per cent in 1912 and to 66.45 per cent in 1913. The changes are mainly due to increased dredging output on the one hand and to decrease in tenor of the great gold-quartz ore bodies worked on the other.

The following table shows the sources by classes of ore, by States, of the gold production of 1913, and for comparison of totals by sources the corresponding figures for 1912 are given:

Source of gold in 1913 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alabama		536.67						536.67
Alaska	516,645.00	232,916.58	6,385.50					755,947.08
Arizona	1,484.67	123,763.86	64,437.34	2,340.62	805.35	445.68	1,379.17	194,656.69
California	427,450.06	542,891.65	15,525.41	1,319.47				987,186.59
Colorado	19,763.12	817,065.19	7,615.92	26,845.88	73.92	1,709.99	4,783.04	877,857.06
Georgia	414.57	316.28						730.85
Idaho	33,574.81	22,341.27	5,032.26	3,404.44	6.00		684.26	65,043.04
Montana	38,748.47	92,749.19	32,084.86	2,114.18	6.00	32.85	3,259.22	168,994.77
Nevada	14,775.75	511,402.36	39,109.98	2,871.40	5.03	2,424.89		570,589.41
New Mexico	380.28	36,839.27	4,697.38	707.91		12.90	25.43	42,663.17
North Carolina	308.53	5,808.39						6,116.92
Oregon	21,799.13	56,781.36	99.99	59.99				78,740.47
South Carolina	10.55	225.57						236.12
South Dakota	67.39	354,000.96		2.50				354,070.85
Tennessee			367.41					367.41
Texas		1.72	1.65	.19			12.89	16.45
Utah	92.88	32,830.03	100,093.39	34,213.80		70.58	5,167.27	172,467.95
Vermont			.14					.14
Virginia		5.18	24.04					29.22
Washington	200.47	33,323.21	158.48	.14				33,682.30
Wyoming	68.06	1,101.84						1,169.90
Total, 1913	1,075,783.74	2,864,900.58	275,633.75	73,880.52	896.30	4,696.89	15,311.28	4,311,103.06
Value	$22,238,424	$59,222,751	$5,697,855	$1,527,246	$18,528	$97,094	$316,512	$89,118,410
Percentage of total	24.96	66.45	6.39	1.71	0.02	0.11	0.36	
Total 1912	1,113,574.77	3,004,663.93	262,388.26	65,213.69	4,880.94	2,299.64	12,489.33	4,465,510.56
Value	$23,019,633	$62,111,916	$5,424,047	$1,348,087	$100,898	$47,538	$258,177	$92,310,296
Percentage of total	24.94	67.29	5.86	1.46	0.11	0.06	0.28	

[a] Philippines and Porto Rico not included.

PLACERS.

The total value of the gold placer production was $22,238,424 in 1913, against $23,019,633 in 1912. These figures represent 24.96 per cent of the total domestic gold output for 1913 and 24.94 per cent of that for 1912. The placer production of Alaska was $10,680,000 in 1913, against $11,990,000 in 1912 and $12,540,000 in 1911, and that of California was $8,836,177 in 1913, against $8,645,663 in 1912 and $8,986,527 in 1911.

Dredging supplied $12,226,976 in 1913 against $11,218,804 in 1912 and $10,311,589 in 1911. Of this California produced $8,090,294 in 1913, against $7,429,955 in 1912, and Alaska $2,200,000 in 1913 and

the same in 1912 and $1,500,000 in 1911. The total production of gold by dredging in California to the end of 1913 has been $63,505,485.

The gold output by dredges and the number of boats producing in the United States and Alaska in 1912 and 1913 are shown in the following table:

Gold output of the United States in 1912 and 1913 and number of dredges producing, by States.

State or Territory.	1912		1913	
	Output.	Number dredges.	Output.	Number dredges.
Alaska	$2,200,000	38	$2,200,000	36
California	7,429,955	65	8,090,294	63
Colorado	384,748	3	372,288	4
Idaho	480,970	8	561,936	6
Montana	710,387	6	685,190	5
Other States	12,744	4	317,268	2
Total	11,218,804	124	12,226,976	116

The remainder of the placer production is chiefly from drift mining (which is of decreasing importance in Alaska in frozen ground at no great depth, but of continued importance in California in ancient buried river channels, often at considerable depth) and from hydraulic and sluicing placers. In California, especially, hydraulic mining has been of much importance in the past and a special branch of the industry in itself, but restrictive laws relative to the débris and to disturbance of navigable streams have in recent years greatly confined mining activity of this kind. Finally, there is also a small annual output of gold from dry placers of the Southwest, and a considerable production of gold and platinum from ocean-beach mining in California and Oregon.

Some interesting notes on beach mining in California and Oregon and on dry placers in California, by Charles G. Yale, and on dry placers in Arizona, Nevada, and New Mexico, by V. C. Heikes, were published in the Survey report on gold and silver for 1912, copies of which can still be had on application to the Director, United States Geological Survey, Washington, D. C.

DRY AND SILICEOUS ORES.

In 1913 dry and siliceous ores, including true gold, gold-silver, and silver ores, and precious metal-bearing ores not classed as copper, lead, zinc, or mixed ores, produced $59,222,751, against $62,111,916 in 1912 and $66,369,199 in 1911. States producing over $1,000,000 in gold from these ores in 1913 ranked as follows: Colorado, California, Nevada, South Dakota, Alaska, Arizona, Montana, and Oregon.

Increased output from this source for 1913 was recorded for Arizona, California, and Oregon and decreased production from Alaska, Colorado, Montana, Nevada, and South Dakota.

The siliceous ores are in part free-milling (amalgamating), as in Alaska, California, and Oregon; in part both amalgamating and concentrating, as in many States; in smaller part simply concentrating

ores, as in parts of Colorado and Arizona; or smelting ores. Tailings both from old dumps and from present milling are largely reworked by concentration and subsequent cyanidation. The all-sliming cyanidation method is also of increasing importance, and crushing is largely by tube mills as well as by stamp and gyratory mills.

The loss in tailings from gold mills is being constantly cut down and the most serious present loss is in tailings from concentrating plants. The chlorination process is of decreasing relative importance. Smelting is mainly of concentrates and of siliceous and pyritic ores, which are also valuable as fluxes. Exact figures of relative output by methods will appear in detail by States in another table.

COPPER ORES.

The production of gold from the electrolytic refining of blister copper smelted from copper ores and concentrates sold or treated in 1913 was $5,697,855, against $5,424,047 in 1912 and $5,450,079 in 1911. Increase in gold output from these ores was made in 1913 in Arizona, California, and Nevada and decrease in Montana and Utah. States producing over $1,000,000 in gold from copper ores in 1913, as in 1912, were Utah and Arizona, in order named, followed by the important contributors of less than $1,000,000—Nevada, Montana, and California in 1913. The output of gold from copper ores in the United States has increased from 5.63 per cent of the total gold yield from all sources in 1911 to 5.86 per cent in 1912, and to 6.39 per cent in 1913.

LEAD ORES.

The yield of gold from refining lead bullion produced from lead ores sold or treated in 1913 was $1,527,246, against $1,348,087 in 1912 and $1,201,606 in 1911. The Utah ores ranked first in output of gold from this source, followed by those of Colorado, as in 1912 and 1911. The remainder of the gold yield from lead ores was chiefly from Idaho, Nevada, Arizona, Montana, and California, in order given. Increases were noted for Utah, Colorado, and California in 1913, and decreases from other States named.

LEAD-ZINC, ZINC, AND OTHER ORES.

Production of gold from lead-zinc ores was $316,512 in 1913, against $258,177 in 1912, but the figures are not satisfactorily comparable for the reason that ores from Montana classed as zinc ores in 1912 produced both lead and zinc in 1913. The output from lead-zinc ores in 1913 was almost wholly from Utah, Colorado, Montana, and Arizona. From zinc ores the gold production was $18,528 in 1913, against $100,898 in 1912, and was chiefly in 1913 from Arizona.

From copper-lead and copper-lead-zinc ores the gold output was $97,094 in 1913, against $47,538 in 1912, and was mainly from Nevada and Colorado.

DISTRIBUTION OF SILVER PRODUCTION OF 1913, BY SOURCES.

The mine production of silver from dry or siliceous ores, copper ores, and lead ores combined in 1913 was 91.15 per cent of the total

output from all sources, against 93.47 per cent in 1912 and 94.21 per cent in 1911. The production from dry or siliceous ores decreased from 41.25 per cent of the total silver output in 1911 to 39.88 per cent in 1912 and to 39.35 per cent in 1913. The output from copper ores increased from 27.43 per cent in 1911 to 28.39 per cent in 1912, but decreased to 25.63 per cent in 1913. The yield from lead ores decreased from 25.53 per cent in 1911 to 25.20 per cent in 1912, but increased to 26.17 per cent in 1913. The lead-zinc ores produced 4.01 per cent, 4.26 per cent, and 7.50 per cent of the total for 1911, 1912, and 1913, respectively, and the small output from copper-lead and copper-lead-zinc ores also increased from 0.47 to 1.01 and to 1.06 per cent.

The following table shows the source of domestic silver production by classes of ores, by States:

Source of silver in 1913 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alabama		117						117
Alaska	58,487	30,897	273,179					362,563
Arizona	270	392,413	2,885,115	498,457	25,153	34,968	111,715	3,948,091
California	35,379	289,119	833,672	220,229				1,378,399
Colorado	4,563	6,270,758	223,108	1,645,186	21,950	491,058	668,632	9,325,255
Georgia	22	53						75
Idaho	7,309	125,839	414,371	7,806,445	2,619		1,632,610	9,989,193
Illinois				3,541				3,541
Michigan			295,173					295,173
Missouri			176	35,444				35,620
Montana	5,623	1,335,602	10,311,807	493,326	18,043	14,557	1,640,243	13,819,201
Nevada	6,363	15,245,541	241,756	313,779	4,191	102,042	176,411	16,090,083
New Mexico	90	1,348,514	197,574	68,923		4,652	11,520	1,631,273
North Carolina	35	1,777						1,812
Oklahoma		1,300						1,300
Oregon	5,493	172,957	154	432				179,036
South Carolina		40						40
South Dakota	8	172,417		277				172,702
Tennessee			108,105					108,105
Texas		409,182	9,605	1,586			7,180	427,553
Utah	13	2,027,542	2,314,348	7,537,361	14,476	105,286	1,085,809	13,084,835
Vermont			105					105
Virginia			960					960
Washington	69	186,696	140,214	4,260				331,239
Wyoming	15	111	831					957
Total	123,739	28,010,875	18,250,253	18,629,246	86,432	752,563	5,334,120	71,187,228
Value	$74,738	$16,918,569	$11,023,153	$11,252,065	$52,205	$454,548	$3,221,808	$42,997,086
Percentage of total	0.17	39.35	25.63	26.17	0.12	1.06	7.50	100.00
Total, 1912	163,955	26,363,436	18,744,661	16,632,377	664,421	654,596	2,810,939	66,034,385
Value	$100,832	$16,213,513	$11,527,966	$10,228,912	$408,619	$402,577	$1,728,728	$40,611,147
Percentage of total	0.25	39.88	28.39	25.20	1.01	1.01	4.26	100.00

[a] Philippines and Porto Rico not included in this table.

PLACERS.

The output of recovered silver from the refining of placer gold was 123,739 fine ounces in 1913, against 163,955 ounces in 1912 and 170,084 ounces in 1911. The production is mainly from Alaska and California.

DRY AND SILICEOUS ORES.

The yield of silver from dry and siliceous ores in 1913 was 28,010,875 fine ounces, against 26,363,436 ounces in 1912 and 25,205,749 ounces in 1911. The output increased in 1913 from 373,255 to 392,413 ounces in Arizona; from 5,397,439 to 6,270,758 ounces in Colorado; from 1,318,505 to 1,335,602 ounces in Montana; from 13,135,677 to 15,245,541 ounces in Nevada; from 1,141,786 to 1,348,514 ounces in New Mexico; and from 404,180 to 409,182 ounces in Texas; but it decreased from 409,873 to 289,119 ounces in California, and from 3,486,562 to 2,027,542 ounces in Utah.

In order of production from this source the five leading States ranked as follows in 1913: Nevada, Colorado, Utah, New Mexico, and Montana. The ranking was the same in 1911 and 1912 except that Montana was fourth and New Mexico was fifth in those years.

With a few notable exceptions, where there are mines producing true silver ores, as in San Bernardino County, Cal., the dry or siliceous ores are gold-silver or silver-gold ores (the latter notable at Tonopah, Nev.). The rich surface outcrops, mainly of chloride silver ores, found and worked in the arid West in the early days, have long since been exhausted in explored territory, and there appears little likelihood of further extensive supply from new finds. Deeper silver deposits may of course at any time be found. With high prices of silver, old silver producers closed down 20 years ago in the West may be reopened and prove productive again.

The Nevada output is mainly from the Tonopah district, and the Colorado production is chiefly from the Leadville, Upper San Miguel, and Sneffels districts. As shown later, a large part of the output of silver from the gold-silver siliceous ores is with the gold by amalgamation and cyanidation and the metals are separated in refining the gold. The remainder is produced by smelting the richer ores, and the silver is then recovered in the refining of the copper or lead bullion.

COPPER ORES.

The production of silver from copper ores was 18,250,253 fine ounces in 1913, against 18,744,661 ounces in 1912 and 16,759,638 ounces in 1911.

The silver production from copper ores is from the electrolytic refining of Lake and blister copper produced by smelting. The copper ores are mainly sulphides (except the Lake ores of Michigan, which are native metal in amygdaloid and conglomerate matrix), and a greater tonnage contains chalcocite than chalcopyrite or cupriferous pyrite. The great disseminated copper deposits of Utah, Arizona, Nevada, and New Mexico are of increasing importance, and the lode deposits of Butte, Mont., have long been famous. The silver tenor of the extensive Chino disseminated deposits of the Santa Rita district, New Mexico, is notably low, but similar deposits elsewhere add important yields of silver. Copper ores, especially sulphides, are mainly concentrated before smelting. Oxidized copper ores, sought for as fluxing ore and commonly smelted crude, still come from the Bisbee district of Arizona and the Tintic district of Utah.

In output of silver from copper ores Montana continued to lead with 10,311,809 ounces in 1913, against 10,655,055 ounces in 1912, 9,597,752 ounces in 1911 and 9,153,590 ounces in 1910; Arizona followed with 2,885,115 ounces in 1913, against 2,378,593 ounces in 1912; and Utah ranked third with 2,314,348 ounces in 1913 against 2,542,381 ounces in 1912. California produced 833,672 ounces in 1913, against 792,445 ounces in 1912. The production of Montana is mainly from Butte, that of Arizona from Bisbee and Jerome, that of Utah from Tintic and Bingham, and that of California from Shasta County. Of these districts Bisbee best represents the disseminated type; Bingham produces from both lode and disseminated deposits; and the remainder furnish the chief supply of silver from copper ores mined from deep lodes.

LEAD ORES.

The silver production from argentiferous lead ores in 1913 was 18,629,246 fine ounces, against 16,632,377 ounces in 1912 and 15,596,638 ounces in 1911. The output from Idaho increased from 7,085,596 ounces in 1912 to 7,806,445 ounces in 1913, that of Utah from 6,212,219 to 7,537,361 ounces, and that of Colorado from 1,470,930 to 1,645,186 ounces. The yield decreased in Nevada from 841,733 to 313,779 ounces, and in Arizona from 599,110 to 498,457 ounces, but increased in Montana from 266,014 to 493,326 ounces, and in California from 35,492 to 220,229 ounces. The output in Idaho has been mainly from the silver-lead ores of the Coeur d'Alene, that in Utah from the Park City and Tintic districts, and that in Colorado from Aspen and Leadville. Although most of this output is from the desilverization of lead bullion from smelting of western sulphide lead ores and concentrates, oxidized silver ores are still mined in small quantities at Tintic, Aspen, and a few other camps.

ZINC, LEAD-ZINC, AND MIXED ORES.

Argentiferous zinc ores supplied 86,432 fine ounces of silver as refinery by-products in 1913, against 664,421 ounces in 1912 and 630,573 ounces in 1911. The output in 1913 was almost wholly from Arizona, Colorado, Montana, and Utah in order named.

Lead-zinc ores furnished 5,334,120 fine ounces of silver in 1913, against 2,810,939 ounces in 1912 and 2,460,152 ounces in 1911. Montana supplied 1,640,243 ounces in 1913, Idaho 1,632,610 ounces, Utah 1,085,809 ounces, and Colorado 668,632 ounces. It is probable that the production from Montana will further increase with continued active production from the large zinc ore bodies at Butte, which carry appreciable contents of silver and lead.

Copper-lead and copper-lead-zinc ores in 1913 produced 752,563 fine ounces of silver, against 654,596 ounces in 1912 and 285,006 ounces in 1911. The production is mainly from Colorado, Utah, and Nevada.

DISTRIBUTION OF PRODUCTION OF GOLD AND SILVER, BY METHODS OF TREATMENT.

In the Survey report on gold and silver for 1910 figures were first published showing the distribution of output by methods of treatment.

In the following table a summary is given of the distribution of the gold and silver production of the United States in 1913, showing—

1. Total crude ore, tailings, and slags sold or treated.
2. Crude ore treated in gold and silver mills.
3. Crude ore concentrated, with resulting concentrates.
4. Crude ore shipped to smelters.
5. Old tailings and slags treated.

The last four include recoverable gold and silver content in fine ounces.

Distribution of production of gold and silver in 1913, by methods of treatment, by States.[a]

State or Territory.	Total quantity of ore, tailings, and slag treated or sold in 1913.	Ore to gold and silver mills.			Ore to concentrating mills.	Concentrates produced.		
		Quantity.	Gold in bullion.	Silver in bullion.	Quantity.	Quantity.	Gold.	Silver.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Short tons.*	*Short tons.*	*Fine ounces.*	*Fine ounces.*
Alaska[b]	1,750,262	1,614,506	138,688	21,762	54,895	44,202	94,229	216,688
Arizona	7,931,862	199,980	111,738	72,899	5,141,337	454,393	14,904	393,553
California	2,495,958	1,905,258	409,700	126,002	.....	32,652	99,829	38,046
Colorado	2,734,866	1,610,335	554,722	443,444	459,533	218,291	123,178	2,320,781
Idaho	2,451,592	53,630	17,552	102,560	2,126,535	269,400	4,272	6,720,969
Montana	5,960,118	173,440	39,028	86,262	4,930,632	1,534,006	29,795	9,100,418
Nevada	5,367,211	1,451,485	467,550	11,923,597	3,451,549	501,888	49,127	2,135,714
New Mexico	2,217,660	124,536	24,891	1,024,363	1,987,896	198,243	7,914	294,948
Oklahoma	29	.....	.....	.....	.....	.....	.....	.....
Oregon	155,901	92,940	37,842	35,397	38,995	4,759	11,798	132,778
South Dakota	1,899,167	1,895,445	349,238	163,359	.....	.....	.....	.....
Texas	25,074	21,559	.....	403,766	3,172	1,166	14	12,396
Utah	10,202,566	75,972	13,117	61,032	8,883,379	525,900	38,555	2,637,873
Washington	115,685	21,658	7,453	25,907	10,793	1,130	75	41,308
Wyoming	4,236	3,272	1,102	111	.....	.....	.....	.....
Eastern or Appalachian States	672,033	17,883	6,727	1,963	.....	1	98	23
Total	43,984,220	9,261,899	2,179,348	14,492,424	27,088,716	3,786,031	473,788	24,045,495
Total, 1912	38,594,806	9,367,335	2,262,951	12,475,279	22,207,305	3,303,655	494,980	22,322,239

State or Territory.	Crude ore to smelter.			Old tailings and slag treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*	*Fine ounces.*	*Fine ounces.*
Alaska[b]	80,861	6,385	65,626	.....	.....	.....
Arizona	2,425,962	65,911	3,403,008	164,583	619	78,361
California	531,189	40,637	1,158,518	59,511	9,571	20,454
Colorado	664,998	180,194	6,556,467	.....	[c]	.....
Idaho	181,414	9,644	3,158,355	90,013	[c]	.....
Montana	811,765	61,423	4,626,898	[d] 44,281	[c]	[c]
Nevada	399,178	37,900	1,902,528	64,999	[e] 1,237	[e] 121,881
New Mexico	105,228	9,478	311,872	.....	.....	.....
Oklahoma	29	.....	1,300	.....	.....	.....
Oregon	1,101	5,021	3,656	22,865	2,280	1,712
South Dakota	3,722	4,765	9,335	.....	.....	.....
Texas	343	2	11,391	.....	.....	.....
Utah	1,165,950	120,358	10,117,066	[d] 77,265	345	268,851
Washington	83,234	25,954	263	.....	.....	.....
Wyoming	964	.....	831	.....	.....	.....
Eastern or Appalachian States	653,150	392	109,170	1,000	67	11
Total	7,109,088	568,064	31,436,284	524,517	14,119	491,270
Total, 1912	6,543,436	578,391	29,729,092	476,730	15,614	775,198

[a] Exclusive of small quantity of silver from copper ores in Michigan and Missouri and from lead ores in Missouri and Illinois.

[b] Small quantity of gold and silver included from copper concentrates included under crude ore smelted.

[c] Included under ore sent to gold and silver mills.

[d] Includes 32,748 tons of copper ore leached in Montana; includes 28,469 tons copper ore leached in Utah.

[e] Gold and silver from 54,172 tons of these tailings are included under recoveries from gold and silver mills.

The first item consists of all classes of ores, tailings, and slag producing gold and silver in the United States in 1913. The grand total shows that this tonnage increased from 30,287,175 short tons in 1910 to 32,928,522 tons in 1911, to 38,594,806 tons in 1912, and to 43,984,220 tons in 1913. This takes no account of placer gravel but represents output of mines producing ore only. The most important increases in material sold or treated were from 6,840,082 tons in 1912 to 7,931,862 tons in 1913 in Arizona, from 2,576,626 to 2,734,866 tons in Colorado, from 2,266,334 to 2,451,592 tons in Idaho, from 5,552,164 to 5,960,118 tons in Montana, from 4,763,965 to 5,367,211 tons in Nevada, from 1,352,286 to 2,217,660 tons in New Mexico, and from 7,770,270 to 10,202,566 tons in Utah. Decreases were noted for Alaska, California, and South Dakota in 1913.

In reference to the second item, many gold and silver mills employ concentrating apparatus, and the concentrates resulting are combined in the table with those from straight concentrating mills, under the heading "Concentrates produced." The gold and silver recovery under this item is mainly by amalgamation and cyanidation, as is shown in detail in the last table of this report. The total quantity of crude ore treated in gold and silver mills of the United States increased from 8,528,596 short tons in 1910 to 9,325,090 tons in 1911 and to 9,367,335 tons in 1912, but decreased to 9,261,899 tons in 1913. Increases in tonnage milled are noted for Arizona, from 198,262 tons in 1912 to 199,980 tons in 1913, for Colorado from 1,435,837 to 1,610,335 tons, for Nevada from 1,309,339 to 1,451,485 tons, for New Mexico from 106,208 to 124,536 tons, and for South Dakota from 1,893,836 to 1,895,445 tons. The principal decreases were from 1,761,799 to 1,614,506 tons in Alaska, from 2,077,300 to 1,905,258 tons in California, from 205,409 to 173,440 tons in Montana, and from 171,117 to 75,972 tons in Utah. The total quantity of gold recovered by mills in 1913 was 2,179,348 fine ounces (valued at $43,581,354), against 2,262,951 ounces in 1912, 2,440,339 ounces in 1911, and 2,366,322 ounces in 1910. There was increased output of gold from mills in Arizona, Colorado, and New Mexico, and decreased production from Alaska, California, Montana, Nevada, South Dakota, and Utah. The total silver recovery in mills was 14,492,424 fine ounces in 1913, against 12,475,279 ounces in 1912, 9,662,545 ounces in 1911, and 8,245,851 ounces in 1910—a continued and marked trend upward. There was increased silver production from mills in Arizona, Colorado, Montana, Nevada (notably in 1913, as in 1912 and 1911 also), New Mexico (notably), and Texas, and decreased output from California, Idaho, South Dakota, and Utah.

Under the third item is given the quantity of ore treated by concentration only, including the large quantities of copper, lead, zinc, and mixed ores, whose concentrates are smelted primarily for these metals, the gold and silver being recovered in refining the copper and lead bullion and smelting the zinc residues. Examples are the copper ores of the disseminated deposits of Bingham, Utah, the copper ores of Butte, Mont., the lead and lead-zinc ores of the Coeur d'Alene, Idaho, Butte, Mont., and Leadville, Colo. The quantity of concentrates produced and the recoverable gold and silver content, however, as already stated, represent not only the concentrates from these straight concentrating mills but also those from gold and silver mills.

The concentrates are mainly smelted, as stated, but are in some cases treated in gold and silver mills by the processes named. Comparison with corresponding figures published by the Survey for earlier years shows that the total tonnage treated in straight concentrating mills (for concentration only) increased from 15,407,515 tons in 1910 to 17,602,315 tons in 1911, to 22,207,305 tons in 1912, and to 27,088,716 tons in 1913. The greater part of the increase in 1912 was in Arizona (from 4,327,705 to 5,141,337 tons), in Idaho (from 1,985,527 to 2,126,535 tons), in Montana (from 4,497,240 to 4,930,632 tons), in Nevada (from 3,010,976 to 3,451,549 tons), in New Mexico (from 1,142,002 to 1,987,896 tons), and in Utah (from 6,477,567 to 8,883,379 tons), and with the exception of Idaho and Montana indicates chiefly increased tonnages of low-grade disseminated copper ores mined. In Idaho and Montana the increase was largely in lead-zinc ores. The total quantity of gold and silver bearing concentrates produced in all classes of mills increased from 2,597,992 tons in 1910, to 2,773,870 tons in 1911, to 3,303,655 tons in 1912, and to 3,786,031 tons in 1913. The chief increases in 1913 were from 411,627 to 454,393 tons in Arizona, from 232,347 to 269,400 tons in Idaho, from 353,563 to 501,888 tons in Nevada, from 81,811 to 198,243 tons in New Mexico, and from 381,358 to 525,900 tons in Utah. The total recoverable gold content of all concentrates aggregated 473,788 ounces, valued at $9,794,069, in 1913, against 494,980 ounces, valued at $10,232,144, in 1912, against 484,971 ounces in 1911, and 475,452 ounces in 1910. The recoverable gold content in concentrates increased chiefly in Arizona, California, and Oregon, and mainly decreased in the other States given. The decreases were mainly due to lowered grade of siliceous gold and silver ores milled and were not offset by large increases in low-grade copper ores milled. The total recoverable silver in concentrates produced aggregated 24,045,495 ounces in 1913, against 22,322,239 ounces in 1912, against 20,794,441 ounces in 1911 and 19,949,379 ounces in 1910. The increased output was most notable in Idaho (from 5,402,543 to 6,720,969 ounces), in Montana (from 8,597,953 to 9,100,418 ounces), and in Oregon (from 37,434 to 132,778 ounces), and was due mainly to increased output of argentiferous lead and zinc concentrates.

The fourth item covers the quantity and recoverable precious metal content of crude ores shipped from the mines direct to smelters, and in general includes the richer gold, silver, copper, lead, and zinc ores from which the gold and silver are eventually recovered by refining the copper or lead bullion that collects the precious metals in the smelting. The total quantity shipped of this class of ore decreased from 6,016,425 tons in 1910 to 5,588,771 tons in 1911, increased to 6,543,436 tons in 1912, and increased again to 7,109,088 tons in 1913. The increase in tonnage for 1913 as compared with that of 1912 was mainly in Arizona (from 2,140,008 to 2,425,962 tons), in California (from 456,735 to 531,189 tons), in Colorado (from 617,726 to 664,998 tons), in Nevada (from 376,800 to 399,178 tons), and in the Eastern or Appalachian States (from 605,951 to 653,150 tons). The decrease was mainly in Montana (from 839,383 to 811,765 tons). The tonnages have been notably large in Arizona and Utah. The total gold output from crude ores smelted decreased from 623,272 fine ounces in 1910 to 611,344 ounces in 1911, to 578,391

ounces in 1912, and to 568,064 ounces (valued at $11,742,925) in 1913. The decreases in gold production from these ores were chiefly in Colorado (from 193,013 to 180,194 ounces), and in Utah (from 138,994 to 120,358 ounces). The total recoverable silver output from crude ores shipped to smelters increased from 28,487,837 fine ounces in 1910 to 29,831,111 ounces in 1911, decreased to 29,729,092 ounces in 1912, but increased to 31,436,284 ounces in 1913. The increases in 1913 were chiefly in Arizona (from 2,982,049 to 3,403,008 ounces), in California (from 955,067 to 1,158,518 ounces), in Colorado (from 5,425,366 to 6,556,467 ounces), in Idaho (from 2,679,943 to 3,158,355 ounces), in Montana (from 4,039,623 to 4,626,898 ounces), in Nevada (from 1,546,220 to 1,902,528 ounces), and in the Eastern States (from 91,398 to 109,170 ounces); and the principal decrease was in Utah (from 10,826,359 to 10,117,066 ounces).

Under the fifth item is given the quantity of old materials, principally slags and tailings, retreated, and their recoverable contents. These are partly smelted, often for their fluxing as well as their metal values; but increasing quantities of old tailings are now concentrated and cyanided, and impounding of mill tailings for future treatment as well as because of legal requirements has now become quite general practice. The Colorado tailings treated are included in the first column of the table with total ore. The concentrates produced from old tailings, and their gold and silver content, are included under "concentrates produced." Comparison of the figures for 1911, 1912, and 1913 shows that the total quantity of all old material treated (except that of Colorado) increased from 412,346 short tons in 1911 to 476,730 tons in 1912 and to 524,517 tons in 1913; but that the recovered gold content decreased from 16,259 fine ounces in 1911 to 15,614 ounces in 1912 and to 14,119 ounces in 1913, and that the silver recovery increased from 99,475 fine ounces in 1911 to 775,198 ounces in 1912 and decreased to 491,270 ounces in 1913.

From this table the output of ore from the Central States, producing small quantities of silver and no gold, has been omitted. The output of zinc ore from the Eastern States is also omitted, as this zinc ore is reported to produce neither silver nor gold.

The following table shows in summary the percentage of total output, by processes, of gold and silver in the United States in 1911, 1912, and 1913:

Percentage of output of gold and silver by processes in the United States in 1911, 1912, and 1913.

Production by—	Percentage of total output.					
	Gold.			Silver.		
	1911	1912	1913	1911	1912	1913
Placers	24.2	24.8	24.9	0.3	0.2	0.2
Gold and silver mills:						
By amalgamation	23.9	22.3	21.5	1.5	1.2	.6
By cyanidation	26.1	30.9	31.2	14.2	17.8	19.7
By chlorination	3.8	.4	.3	.....	.....	.....
Total milling	53.8	53.6	53.0	15.7	19.0	20.3
Smelting[a]	22.0	21.6	22.1	84.0	80.8	79.5
Total[b]	100.0	100.0	100.0	100.0	100.0	100.0

[a] Both crude ore and concentrates. [b] Philippines and Porto Rico excluded.

The placers produced 24.2 per cent of the total gold output in 1911, 24.8 per cent in 1912, and 24.9 per cent in 1913, a slight but steady increase. The placers produced only 0.3 per cent of the total silver production in 1911, and 0.2 per cent in 1912 and 1913.

The mills contributed 53.8 per cent of the total gold output in 1911, 53.6 per cent in 1912, and 53 per cent in 1913, and increased the output of silver from 15.7 per cent in 1911, to 19 per cent in 1912, and to 20.3 per cent in 1913. They are therefore producing a slightly less proportion of the gold but a slightly greater proportion of the silver each year. The production by amalgamation has been less important both of gold and of silver in the last three years, being 23.9 per cent of the total gold and 1.5 per cent of the total silver in 1911; 22.3 per cent of the gold and 1.2 per cent of the silver in 1912; and 21.5 per cent of the gold and 0.6 per cent of the silver in 1913. The cyanidation process has contributed constantly increasing proportions of both gold and silver production, yielding 26.1 per cent of the gold and 14.2 per cent of the silver in 1911; 30.9 per cent of the gold and 17.8 per cent of the silver in 1912; and 31.2 per cent of the gold and 19.7 per cent of the silver in 1913. The chlorination process has produced a declining proportion of the gold yield, 3.8 per cent in 1911, 0.4 per cent in 1912, and only 0.3 per cent in 1913. The smelters have produced an average of nearly 22 per cent of the total gold yield during the last three years but the smelter output of silver has declined from 84 per cent in 1911 to 80.8 per cent in 1912, and to 79.5 per cent in 1913. The bulk of the silver production is still therefore from the smelting of crude ore, concentrates, and other material, but the proportion declines as the relative recovery by cyanidation increases each year. The bulk of the gold output is still from the placers and from amalgamation, cyanidation, and smelting, in nearly equal proportions, the small changes in importance of each method of recovery being indicated above.

The following table shows in greater detail the tonnage treated and the output of precious metals by gold and silver mills, by States, in 1913:

Quantity of ore treated at gold and silver mills in 1913, giving recoveries by amalgamation and cyanidation and percentage of each to gold and silver recovered from all sources.[a]

State.	Ore and tailings treated.	Bullion recovered.				Percentage of gold and silver from all sources.			
		Amalgamation.		Cyanidation.		Amalgamation.		Cyanidation.	
		Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*				
Alaska	1,614,506	136,122	20,627	91,531	9,135	18.0	5.7	12.1	2.5
Arizona	199,980	14,615	3,759	97,123	69,140	7.5	0.09	49.9	1.7
California [b]	1,964,769	360,102	66,848	62,372	77,788	36.5	4.9	6.3	5.6
Colorado [c]	1,610,335	85,022	77,438	462,483	365,965	9.7	0.8	41.7	3.9
Idaho	56,046	8,462	5,104	9,090	97,456	13.0	.05	14.0	1.0
Montana	173,440	2,344	1,407	36,684	84,855	1.4	0.01	21.6	0.7
Nevada	1,505,657	64,283	33,581	403,267	11,890,016	11.3	0.2	70.7	73.9
New Mexico	124,536	2,424	300	22,467	1,024,063	5.5	0.02	52.6	62.8
Oregon	115,798	27,726	4,712	12,140	30,919	35.2	2.6	15.4	17.3
South Dakota	1,895,445	224,649	65,636	124,589	97,673	63.4	38.0	35.2	56.6
Texas	21,559	.....	148,625	.....	255,141	.....	34.8	.....	59.7
Utah	75,972	361	312	12,756	60,720	.2	.....	7.4	.4
Washington	21,658	727	318	6,726	25,589	2.2	.1	20.0	8.0
Wyoming	3,272	49	6	[d] 1,053	105	4.2	.6	90.0	10.1
Appalachian States	18,883	686	121	6,041	1,842	8.5	.1	75.3	1.7
Total	9,401,856	927,572	428,844	1,348,322	14,090,407	[e] 21.3	[e] 0.6	[e] 31.0	[e] 19.8
Value	.....	$19,174,615	$259,022	$27,872,289	$8,510,606	.....	.....	.....	.....
Total, 1912	9,667,360	1,003,470	795,755	1,386,526	11,728,730	22.3	1.2	30.9	17.8

[a] Porto Rico and Philippines excluded.
[b] Also 4,208.53 fine ounces of gold and 13 ounces of silver recovered by chlorination.
[c] Gold recovered by chlorination was 7,217 ounces, silver 41 ounces.
[d] Contains small quantity of gold recovered by amalgamation.
[e] Percentage of production reported by mines in United States.

Figures corresponding to those in this table were collected and compiled for the entire United States by the Survey for the first time in 1911, and comparison for three years can therefore now be made.

The total quantity of crude ore and old tailings treated in gold and silver mills in 1913 was 9,401,856 short tons, against 9,677,360 tons in 1912 and 9,670,483 tons in 1911.

The great bulk of the ore treated, as shown, was milled in California, South Dakota, Alaska, Colorado, and Nevada, in order named, and here the famous mills of the Mother Lode and Grass Valley, Homestake, Treadwell, Cripple Creek, Tonopah, and Goldfield mines are especially in evidence. Large numbers of smaller mills, however, mark the wide distribution, of gold mining especially, in nearly every mountain range. These plants range from small prospecting mills with from 1 to 3 light stamps, simple amalgamating apparatus, and usually no concentrating apparatus, through the conventional 5-stamp, 10-stamp, 15-stamp, and 20-stamp mills—with plants varying widely, according to local ore characteristics, in weight and drop of stamps, rapidity and fineness of discharge, and arrangement for amalgamation and concentration—to the great mills above mentioned which treat enormous tonnages daily and represent the high-water mark in milling and metallurgy of the precious metals.

The tonnages treated in gold and silver mills, with increase and decrease for 1913, have been noted in connection with a preceding table.

The total yield of gold by amalgamation in the United States in 1913 was 927,572 fine ounces, valued at $19,174,615, against 1,003,470 ounces, valued at $20,743,266, in 1912, and against 1,120,344 ounces, valued at $23,159,566, in 1911. The principal decreases for 1913 as compared with 1912 were from 141,470 to 136,122 ounces in Alaska, from 391,421 to 360,102 ounces in California, from 93,283 to 85,022 ounces in Colorado, from 88,979 to 64,283 ounces in Nevada, and from 241,502 to 224,649 ounces in South Dakota. The principal increase was from 7,953 ounces in 1912 to 27,726 ounces in 1913 in Oregon. California, South Dakota, and Alaska continued the greatest producers of gold by amalgamation in the order named. The total yield of silver by amalgamation was 428,844 fine ounces, against 795,755 ounces in 1912. The production is largely from Texas (where pan amalgamation has been used), followed by Colorado, California, and South Dakota, and the decreases were marked in Texas and California. The recovery in Colorado, California, and South Dakota is mainly incidental to the extraction of gold.

The total output of gold by cyanidation in 1913 was 1,348,322 fine ounces, valued at $27,872,289, against 1,386,526 ounces, valued at $28,662,036, in 1912, and against 1,259,400 ounces, valued at $26,034,108, in 1911. The bulk of the output was in Colorado, Nevada, South Dakota, Arizona, and Alaska in order named. The increases were chiefly in Arizona (from 90,812 to 97,123 ounces), in California (from 51,423 to 62,372 ounces), in Colorado (from 458,591 to 462,483 ounces), in New Mexico (from 18,561 to 22,467 ounces), and in Oregon (from 2,525 to 12,140 ounces). The main decreases were in Alaska (from 97,369 to 91,531 ounces), in Montana (from 40,957 to 36,684 ounces), in Nevada (from 444,633 to 403,267 ounces), in South Dakota (from 132,669 to 124,589 ounces), and in Utah (from 21,148 to 12,756 ounces). The total output of silver by cyanidation was 14,090,407 fine ounces in 1913, against 11,728,730 ounces in 1912 and 8,781,552 ounces in 1911. The principal increases for 1913 as compared with 1912 were from 42,738 to 69,140 ounces in Arizona, from 72,715 to 77,788 ounces in California, from 355,462 to 365,965 ounces in Colorado, from 61,201 to 84,855 ounces in Montana, from 9,941,876 to 11,890,016 ounces in Nevada, from 841,575 to 1,024,063 ounces in New Mexico, and from nothing to 255,141 ounces in Texas (where pan amalgamation is now being largely supplanted by cyanidation).

In addition to these recoveries by amalgamation and cyanidation the rapidly declining chlorination process yielded $236,188 in gold in 1913 against $339,432 in 1912. The output was $86,998 from Colorado and $149,190 from California in 1913.

According to the percentages of the total output from all sources of gold and silver amalgamation yielded 21.5 per cent of the gold and 0.6 per cent of the silver in 1913 against 22.3 per cent of the gold and 1.2 per cent of the silver in 1912. Cyanidation yielded 31 per cent of the gold and 19.7 per cent of the silver in 1913 against 30.9 per cent of the gold and 17.8 per cent of the silver in 1912. The decrease in relative output by amalgamation is therefore pretty well offset by the increase by cyanidation. Amalgamation in 1913 pro-

duced 63.4 per cent of the total gold and 38 per cent of the total silver in South Dakota; 34 per cent of the total silver in Texas; 35 per cent of the total gold in Oregon; 36.5 per cent of the gold in California; and 18 per cent of the gold in Alaska. Cyanidation produced 90 per cent of the total gold in Wyoming in 1913; 75.3 per cent of the gold output of the Appalachian States; 70.7 per cent of the gold and 73.9 per cent of the silver in Nevada; 52.6 per cent of the gold and 62.8 per cent of the silver in New Mexico; 49.9 per cent of the gold in Arizona; and 41.7 per cent of the gold in Colorado; 35.2 per cent of the gold and 56.6 per cent of the silver in South Dakota; and 59.7 per cent of the silver in Texas.

For details of consumption of quicksilver in the amalgamation process and of potassium and sodium cyanide in the cyanide process in several of the Western States, the reader is referred to the separate mines reports indicated in the prefatory note. Data as to consumption of these supplies are not yet furnished by a sufficient number of mining and milling companies to justify tabulation for the entire United States.

INDEX.

A. Page.

Abrasive materials, summary cxxxvi
Acid, open-hearth steel 331
Adirondack district, iron ore 299
Africa, chromic iron ore 31
cobalt 339
copper 581
gold 849
iron ore 314, 318
lead 713
manganese ore 73
tungsten 360
Alabama, bauxite 1-2, 10
cooperation ix
gold 845, 854, 862, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report) 178–179
iron ore 296–298, 304, 305
manganese ore 61
pig iron 320–321
silver 845, 854, 868, 875, 878
value of mineral products xxiii
Alaska, copper 533, 542–543
gold 845, 854, 855, 868, 872–878
gold, silver, and copper (mines report), by A. H. Brooks 213–225
lead 713, 718, 722
quicksilver 210
silver 845, 854, 856, 868, 875, 878
tin 347
tungsten 353
value of mineral products xxv
Algeria, iron ore 314, 318
Alizarin, imports, summary clxvii
Aluminum 14–27
(*See also* Bauxite and aluminum.)
alloys 21–25
Aluminum Co. of America 16–17
bibliography 26–27
exports ..... 14, clxvii
extraction 20
industry, expansion of 15–17
in France 20–21
market 17–18
prices 17–18
curve showing price by months 18
production and consumption 14
salts, production 25
imports ..... 25, clxvi
secondary 80
Serpek process 11–12
Southern Aluminum Co 15–16
summary cxxx
uses, new 18–20
American Iron and Steel Institute 318
statistics of pig iron and steel 319

Page.

Analyses, bauxite 5, 14
chromic iron ore 34, 37
chromium alloy 38
platinum ore 449–450, 451
tungsten ore 354
Aniline salts, summary clxvii
Animikie range, iron ore 308
Anthracite, summary ..... cxxxiii, clxvii–clxviii
pig iron 323–324
Antikoken range, iron ore 308
Antimonial lead 711, 715, 745
summary cxxx
Antimony, by Frank L. Hess 279–282
consumption 281
imports ..... 280–281, clxvi
prices 281
production 279
salts, imports ..... 281, clxvi
secondary antimony 78, 80
summary cxxxii
Argentina, copper 581
gold 849
tungsten 361
Arizona, copper 533, 543–554
gold 845, 854, 856–857, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report), by V. C. Heikes 673–707
lead 713, 718, 722, 725
quicksilver 197, 199, 200, 202
silver 845, 854, 857, 868, 875, 878
tungsten 353–354
value of mineral products xxvi
zinc 623, 629, 632, 635
Arkansas, bauxite 1–2
lead 713, 715, 718, 722, 724
manganese ore 58, 61, 62
manganiferous ore 64–65
silver, copper, lead, and zinc (mines report), by J. P. Dunlop 86–90
value of mineral products xxvii
zinc 623, 629, 632
Arsenic, by Frank L. Hess 283–284
consumption 284
imports 283
production 283
Arsenious oxide, summary ..... cxxxvii, clxvii
Artificial abrasions, summary cxxxvi
Asbestos, summary ..... cxxxix, clxvii
Ashland, shipments of iron ore 310
Ashtabula, Ohio, receipts of iron ore 310, 311–312
Asphalt, summary ..... cxxxix, clxvii–clxviii
Australasia, copper 581
gold 849
Australia, bismuth 288
chromic iron ore 30

Page.

Australia, copper 581
imports from 577
iron ore, production 318
lead 728, 740
manganese ore 63, 73
molybdenum 341
platinum 450
tungsten 360–361
zinc 636–638, 639–640, 647
Austria, antimony 279
copper 581
exports to 578
quicksilver 210
tungsten 361
zinc 647, 659
secondary 647
Austria-Hungary, gold 849
iron ore 318
lead 728, 740
manganese ore 63

B.

Baraboo range, iron ore 308, 314
Barium compounds, imports ..... cxxxix, clxvii
Barytes, summary ..... cxxxix, clxvii
Basic pig iron, production 324
steel 331
Bauxite and alumin um, by W. C. Phalen 1–27
Bauxite 1–14
Alabama 1–2, 10
analyses 5, 14
Arkansas 1–2
consumption 2
Georgia 1–2
Bartow County 9–10
Hermitage district 8–9
Rome district 9
imports ..... 2, clxvi
industry, by States 3–10
prices 1
production, by States 1–2
of alumina from clay 10–11
by Serpek process 11–12
summary cxxx
Tennessee 1–2, 3–7
Chattanooga district 3, 5
Keenburg 5–7
uses 12–14
world's production 2
Belgian Congo, manganese ore 73
Belgium, copper, exports to 578
iron ore 318
imports from 314
lead 728, 740
manganese ore 63
imports from 62
zinc 647, 659
secondary 647
Bessemer, iron ore 313
pig iron, production 324
steel 331, 333
Billiton, tungsten 361
Birmingham district, iron ore 299
Bismuth, by Frank L. Hess 285–288
imports ..... 287, clxvi
prices 288

Page.

Bismuth, production 285–287
by countries 288
summary cxxxii
Blast furnaces, by States 321–322
Bolivia, bismuth 288
copper 581
gold 849
quicksilver 211
tin 347
tungsten 361
Borax, summary ..... cxxxvii, clxvii
Borneo, platinum 450
Bosnia, chromic iron ore 30
manganese ore 63
Boyne City, Mich., iron-ore receipts 311
Brass, old, imports of 654
remelted 80
Brazil, gold 849
manganese ore 63
imports from 62
palladium 448
quicksilver, exports to 211
tungsten 361
British Columbia, lead imports 733
molybdenum 341
British East Indies, chromic iron ore 31
gold 849
manganese ores, imports from 62
British Guiana, gold 849
British North America, copper, exports to 578
lead, imports from 733
Bromine, summary cxxxvii
Brooks, A. H., paper on gold, silver, and copper in Alaska (mines report) 213–225
Buffalo, N. Y., receipts of Lake Superior iron ore 310, 311–312
Bulgaria, manganese ore 73
Burchard, Ernest F., paper on iron ore, pig iron, and steel 291–338
Bureau of the Mint 846
Burma, tungsten 357, 360
Burrstones and millstones, summary ..... cxxxvii, clxvii
Butler, B. S., paper on copper 523–581
on silver, copper, lead, and zinc in Central States (Michigan) (mines report) 104–114

C.

Cadmium, by C. E. Siebenthal 669–671
imports 671
prices 671
production 669–670
in Germany 670
summary ..... cxxxii, clxvi
Calcium chloride, summary cxxxvii
California, bismuth 286
chromic iron ore 29, 33–36
copper 533, 555, 557
gold 845, 854, 857–858, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report), by C. G. Yale 459–507
iron ore 296–298, 305
lead 713, 718, 722, 725
manganese ore 58–61
pig iron 320–321

Page.

California, platinum 445
quicksilver 197, 199, 200, 202–207
silver 845, 854, 858, 868, 875, 878
tungsten 353, 354–355
value of mineral products xxx
zinc 623, 629, 632, 635
Canada, chromic iron ore 30, 31, 38
cobalt 339–340
copper 581
exports to 578
imports from 577
gold 849
iron ore 318
imports from 314
lead 713, 728, 740
bounty 742, 744
manganese ore 63, 73–74
imports from 62
nickel 343
platinum 448, 450
quicksilver, exports to 211
zinc ore, imports from 623, 636, 653–654
Cape Colony, copper 581
manganese ore 63
Cement, summary cxxxiv, clxvii–clxviii
Central America, gold 849
lead 713
quicksilver, exports to 211
Charcoal pig iron, production 324
Chattanooga district, iron ore 299
Chile, copper 581
imports from 577
gold 849
iron ore 318
lead, imports from 733
China, antimony 279
gold 849
iron ore 318
tin 347
Chosen (Korea), gold 849
iron ore, production of 318
quicksilver, exports to 211
Chromic iron ore, by J. S. Diller 29–39
alloys 38–39
composition 38
analyses 34, 37
distribution in United States 33–36
foreign sources 36–38
ferrochromium 39, 330
imports 31–32, 330
ores of 32–33
prices 30
production 29
publications 38–39
summary cxxxi, clxvi
thermal resistivity 39
world's production 30
Clay, summary cxxxv, clxvii
Clay products, summary cxxxv, clxvii–clxviii
Cleveland, Ohio, receipts of iron ore 310, 311–312
Coal, summary cxxxiii, clxvii–clxviii
bunker clxiviii
briquets, summary cxxxiii
Coal-tar products, summary clxvii
Cobalt, by Frank L. Hess 339–340
Canada 339–340
imports 340, clxvi

Page.

Cobalt, Kongo 339
New Caledonia 340
price 340
production 339
summary cxxxi, clxvi
Coke, summary cxxxii, clxvii–clxviii
pig iron 323–324
Colombia, gold 849
platinum 450, 454–456
quicksilver, exports to 211
Colorado, bismuth 285
cadmium 669–670
copper 533, 557
gold 845, 854, 858, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report), by C. W. Henderson 41–55
iron ore 296–298, 304, 305
lead 713, 718, 722, 725
manganiferous iron ore 64–65
silver ore 59
pig iron 320–321
gold, silver, copper, lead, and zinc (mines report), by C. W. Henderson 227–278
radium 363–364
selenium 289
silver 845, 854, 858, 868, 875, 878
tungsten 353, 355–356, 359
uranium 363–364
value of mineral products xxxii
vanadium 363–364
zinc 623, 629, 632, 635
Conneaut, Ohio, Lake Superior iron ore, receipts 310, 311–312
Connecticut, iron ore 296–298, 304, 305
pig iron 320–321
value of mineral products xxxiv
Copper, by B. S. Butler 523–581
casting copper 573–574
condition of industry 524–526
consumption 578–579
electrolytic copper 574
exports, by countries 577–578
geologic classification of copper deposits 526–527
imports by countries 577
Lake copper 574
ore 537–541
gold in 537
percentage of copper, by States 537–539
silver in 537
tonnage, by States 537–540
yield 539, 540–541
prices 580
at New York in 1913 580
1850–1913 clxxiii
production 527–573
according to locality of smelting 524, 531
from 1845 to 1913 528
by principal districts 535–536
by States 532–535
total by States 534
mine returns 531–532
refinery 573–576
refined copper, total 575–576
review, by States 541–573
secondary 77, 80, 574–575
smelter and mine 527–541
smelter returns 529–531

Page.

Copper production, smelting plants 530
sulphate 576
tonnage and yield of ores 537–541
stocks 576
summary ..... cxxix, clxvi–clxvii
of statistics 524
uses 579–580
value 524, 527
in gold and silver, per ton 537, 539
world's production 581
Cornwall, tin 347
Corundum and emery, summary .... cxxxvi, clxvii
Costa Rica, quicksilver, exports to 211
Crucible steel 331, 333
Cryolite, summary ..... cxxxvii, clxvii
Cuba, copper 581
imports from 577
gold 849
iron ore 316–317, 318
imports from 314
industry 316–317
manganese ore, imports from 62
quicksilver, exports to 211
Cuyuna range, iron ore 308–309

D.

Day, David T., platinum and allied metals. 445–457
Delaware, value of mineral products xxxv
Denmark, secondary spelter 647
Detroit, Mich., receipts of iron ore 310
Diatomaceous (infusorial) earth, summary, cxxxvi, clxvii
Director of the Mint 846
Diller, J. S., chromic iron ore 29–39
District of Columbia, value of mineral products xxxv
Dominican Republic, quicksilver, exports to. 211
Duluth, shipments of iron ore 310
Dunlop, J. P., paper on silver, copper, lead, and zinc in the Central States (mines reports) 81–171
on metals and metallic ores 747–753
on secondary metals 75–80
Dutch East Indies, gold 849
Dutch Guiana, gold 849
Dutch West Indies, quicksilver exports to .. 211

E.

East Indies, tungsten 361
East Jordan, Mich., iron-ore receipts 311
Ecuador, gold 849
quicksilver, exports to 211
Egypt, iron ore 314
Electric steel 331–332
Elk Rapids, Mich., iron-ore receipts 311
Emery, summary ..... cxxxvi, clxvii
England, cadmium 669
copper 581
tungsten 361
Erie, Pa., receipts of Lake Superior iron ore 310, 311–312
Escanaba, shipments of iron ore 310
Exports, aluminum ..... 14, clxvii
asphalt clxviii
cement clxviii
clay products clxviii

Page.

Exports, coal clxviii
coke clxviii
copper ..... 578, clxvii
fertilizers clxviii
gasoline clxviii
gold ..... 850, clxix
iron ore ..... 315–316, clxvii
lead ..... 733–734, clxvii
lime clxviii
marble and stone clxviii
nickel ..... 345, clxvii
petroleum clxviii
paraffin clxviii
quicksilver ..... 211, clxvii
salt clxviii
silver ..... 850, clxix
slate clxviii
sulphur clxviii
uranium ore 364
zinc 626, 655
foreign 656
oxide ..... 626, clxviii

F.

Fairport, Ohio, receipts of Lake Superior iron ore 310, 311–312
Federated Malay States, tin 348
tungsten 360
Feldspar, summary cxl
Ferro-alloys 328–330
imports ..... 330, clxvi
production 329
summary ..... cxxviii, clxvi
Ferrochromium 39, 330
summary ..... cxxix, clxvi
Ferromanganese (*see also* Manganese ore) 66–68
imports ..... 67–68, 330, clxvi
prices 67
production 67, 324, 329
summary ..... cxxix, clxvi
Ferromolybdenum 329–330, 341
summary ..... cxxix, clxvi
Ferrophosphorus 329–330
summary ..... cxxix, clxvi
Ferrosilicon 324, 329–330
summary ..... cxxix, clxvi
Ferrotitanium 329–330, 351
summary ..... cxxix, clxvi
Ferrotungsten 329–330
summary ..... cxxix, clxvi
Ferrovanadium 329, 330
summary clxvi
Fertilizers, summary ..... cxl, clxvii–clxviii
Fibrous talc, summary cxlii
Finland, gold 849
platinum 448
Flint pebbles, summary ..... cxli, clxvii
Florida, cooperation ix
value of mineral products xxxvii
Fluorspar, summary ..... cxxxvii, clxvii
Forge and foundry iron, production 324
France, aluminum industry 20–21
antimony 279
bauxite 2
copper, exports to 578
gold 849

Page.
France, iron ore 318
lead 728, 740
manganese ore 63
imports from 62
tungsten 361
zinc 647, 659
secondary 647
French Africa, iron ore 314, 318
French Guiana, gold 849
French Indo-China, tungsten 360
Fruitport, Mich., iron-ore receipts 311
Fuller's earth, summary ..... cxl, clxviii
Furnace flux, summary cxxxvi

G.

Garnet (abrasive), summary cxxxvi
Gary, Ind., iron-ore receipts 311
Gasoline, summary ..... cxxxiv, clxviii
Gems and precious stones, summary ..... cxl, clxvii
Georgia, bauxite 1–2, 8–10
cooperation ix
gold 845, 854, 862, 868, 872
gold, silver, copper, lead, and zinc (mines report) 180–182
iron ore 296–298, 304, 305
manganese ore 58, 61
manganiferous ore 65
pig iron 319
silver 845, 854, 868, 875
value of mineral products xxxix
German East Africa, imports of lead ore 733
Germany, bismuth 288
cadmium 670
cobalt 339
copper 581
exports to 578
imports from 577
gold 849
iron ore 318
imports 314
lead 728, 740
imports from 733
manganese ore 63, 74
imports from 62
platinum 456
tungsten 361
zinc 647, 659
secondary 647
Gerry, C. N., paper on gold, silver, copper, lead, and zinc in Idaho (mines report) 755–788
in Washington (mines report) 789–801
Glass sand, summary cxxxv
Gogebic range, iron ore 308–309, 313
Gold and silver, paper by H. D. McCaskey 845–885
copper ores 868, 874, 876
copper, lead ores 869
distribution, by States and sources of gold production of 1913 ..... 845, 871–874
of silver production of 1913 ..... 845, 874–877
by methods of treatment 877–885
percentage of output by processes 882–885
dry and siliceous ore 868, 873, 876
exports ..... 850, clxix
imports ..... 850, clxix
increase and decrease, by States 846

Page.
Gold and silver, lead ores 868, 874, 877
lead-zinc ores 869, 874, 877
mines report 851–885
number of mines 865
method of collecting statistics 851–852
comparison of mint report and mines report 853–854
production of gold and silver reported from mines 854–855
by States and Territories 855–865
ore production, classification, and average values 867–871
placers 872–873, 875
dredges 873
price of silver 847
1850–1913 clxxiii
production by States in 1913 845
since 1792 849
since 1880 850
silver, average tenor of, in ores, by mining districts 871
summary cxxix
tonnage 869
units of measurement 854
value, average, per ton of ore 868–871
world's production of gold 847–849
zinc ores 869, 877
Gold, silver, copper, lead, and zinc in Western States (mines reports):
Alaska, by A. H. Brooks 213–225
Arizona, by V. C. Heikes 673–707
California, by C. G. Yale 459–507
Colorado, by C. W. Henderson 227–278
Idaho, by C. N. Gerry 755–788
Montana, by V. C. Heikes 583–620
Nevada, by V. C. Heikes 803–844
New Mexico, by C. W. Henderson 415–439
Oregon, by C. G. Yale 508–522
South Dakota, by C. W. Henderson 41–49
Texas, by C. W. Henderson 440–443
Utah, by V. C. Heikes 365–413
Washington, by C. N. Gerry 789–801
Wyoming, by C. W. Henderson 49–55
Gold, silver, copper, lead, and zinc in Eastern States (mines report), by H. D. McCaskey 173–196
Number of mines and ore output 176–177
Precious and semiprecious metal industry in Eastern States 177–178
Production 173–175
Publications 194
Review by States 178–194
Alabama 178–179
Georgia 180–182
Maine 183
Maryland 183
Massachusetts 183
New Hampshire 183
New Jersey 183–184
New York 184
North Carolina 184–187
Pennsylvania 188
South Carolina 188–189
Tennessee 189–192
Vermont 192
Virginia 192–194
Granite, summary clxvii
Graphite, summary ..... cxl, clvii

Page.
Great Britain, chromic iron ore..... 31
copper, exports..... 578
imports..... 577
gold..... 849
iron ore..... 318
imports from..... 314
lead..... 728, 733, 740
quicksilver, exports to..... 211
tin..... 347
tungsten..... 361
zinc..... 647, 659
secondary..... 647
Greece, chromic iron ore..... 30, 31, 33, 37
iron ore..... 318
imports from..... 314
lead..... 728
manganese ore..... 63
Guatemala, quicksilver, exports to..... 211
Grindstones, summary ..... cxxxvi, clxvii
Guiana, gold..... 849
Gypsum, summary ..... cxxxv, clxvii

H.

Heikes, V. C., gold, silver, copper, lead, and zinc in Arizona (mines report).. 673–707
Montana (mines report)..... 583–620
Nevada (mines report)..... 803–844
Utah (mines report)..... 365–413
Henderson, Charles W., gold, silver, copper, lead, and zinc in Colorado (mines report) 227–278
New Mexico (mines report)..... 415–439
South Dakota (mines report)..... 41–49
Texas (mines report)..... 440–443
Wyoming (mines report)..... 49–55
Herzegovina, chromic iron ore..... 30
manganese ore..... 63
Hess, Frank L., paper on antimony..... 279–289
arsenic..... 283–284
bismuth..... 285–288
selenium and tellurium..... 289
tin, tungsten, nickel, cobalt, vanadium, molybdenum, radium, titanium, and uranium..... 339–364
Hewett, D. F., paper on manganese and manganiferous ores..... 57–74
Holland, lead..... 740
zinc..... 647, 659
secondary..... 647
Honduras, quicksilver, exports to..... 211
Hones, oilstones, summary ..... cxxxvii, clxvii
Hongkong, quicksilver, exports to..... 211
Hungary, copper..... 578, 581
manganese ore..... 63
Huron, Ohio, receipts of iron ore..... 310, 311–312

I.

Idaho, copper..... 533, 557–558
gold..... 845, 854, 858–859, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report), by C. N. Gerry..... 755–788
iron ore..... 296–298, 305
lead..... 713, 718, 722, 725
quicksilver..... 207
silver..... 845, 854, 859, 868, 875, 878
tungsten..... 353, 356
Page.
Idaho, value of mineral products..... xl
zinc..... 623, 629, 632, 635
Illinois, cooperation..... ix
ferromanganese..... 66–68
lead..... 713, 715, 718, 722, 724
pig iron..... 320–321
silver, copper, lead, and zinc (mines report), by J. P. Dunlop..... 90–95
silver..... 845, 854, 860
value of mineral products..... xliv
zinc..... 623, 629, 632, 634
Imports, alizarin..... clxvii
aluminum salts..... 25, clxvi
aniline salts..... clxvii
antimony..... 281, clxvi
salts..... 281, clxvi
arsenic sulphides..... 283, clxvii
asbestos..... clxvii
asphalt..... clxvii
barium compounds..... clxvii
barytes..... clxvii
bauxite..... 2, clxvi
bismuth..... 287, clxvi
borax..... clxvii
brass, old..... 654
burrstones..... clxvii
cadmium..... 671, clxvi
cement..... clxvii
chromic iron ore..... 31–32, clxvi
chromium salts..... clxvi
clay..... clxvii
clay products..... clxvii
coal..... clxvii
coal-tar products..... clxvii
cobalt oxide..... 340, clxvi
coke..... clxvii
copper..... 577, clxvi
corundum..... clxvii
cryolite..... clxvii
diatomaceous (infusorial) earth, rotten stone, and tripoli..... clxvii
ferrochrome..... 330, clxvi
ferromanganese..... 67–68, 330, clxvi
ferromolybdenum..... 330, clxvi
ferrophosphorus..... 330, clxvi
ferrosilicon..... 330, clxvi
ferrotitanium..... 330, clxvi
ferrotungsten..... 330, clxvi
ferrovanadium..... 330, clxvi
fertilizers..... clxvii
flint pebbles..... clxvii
fluorspar..... clxvii
fuller's earth..... clxvii
gasoline..... clxviii
gems and precious stones..... clxvii
gold..... 850, clxix
granite..... clxvii
graphite..... clxvii
grindstones..... clxvii
guano..... clxvii
gypsum..... clxvii
hones, whetstones..... clxvii
iron ore..... 314–315, clxvi
kaolin..... clxvii
lead..... 730–733, clxvi
paints..... clxvii

Page.
Imports, lime ... clxvii
magnesite ... clxvii
manganese ore ... 62, clxvi
marble and stone ... clxvii
mica ... clxvii
mineral waters ... clxvii
molybdenum ... 330, 341, clxvi
monazite and thorium oxide ... clxviii
nickel ... 344, clxvi
ocher ... clxviii
ozokerite ... clxviii
palladium ... clxvii
paraffin ... clxviii
peat ... clxviii
petroleum ... clxviii
phosphates ... clxvii
platinum ... clxvi
potassium chloride ... clxvii
sulphate ... clxvii
pumice ... clxviii
pyrite ... clxviii
quicksilver ... 211, clxvii
radium salts ... 364, clxvii
salt ... clxviii
sand and gravel ... clxviii
sienna and umber ... clxviii
silver ... 850, clxix
slate ... clxviii
sodium nitrate ... clxvii
spiegeleisen ... 67–68, 330, clxvi
strontium salts ... clxviii
sulphur ... clxviii
talc ... clxviii
thorium nitrate ... clxviii
tin ... 349, clxvii
titanium ... 330, clxvi
tungsten ... 330, clxvii
type metal ... 732, clxvii
uranium salts ... clxvii
venetian red ... clxviii
zinc ... 626, 651–654, clxvii
dust ... 653
oxide ... 626, 654, clxviii
India, bauxite ... 2
chromic iron ore ... 30, 31, 38
gold ... 849
iron ore ... 318
manganese ore ... 57, 63
imports from ... 62
tungsten ... 360
Indiana, pig iron ... 320–321
value of mineral products ... xlvi
Indiana Harbor, Ind., iron-ore receipts ... 311
Indo-China, gold ... 849
tungsten ... 360
Infusorial earth. (*See* Diatomaceous earth.)
Iowa, cooperation ... ix
lead ... 713, 715, 718, 722, 724
silver, copper, lead, and zinc (mines report), by J. P. Dunlop ... 95–96
value of mineral products ... xlviii
zinc ... 623, 633
Iridium (*see* Platinum and allied metals). 456–457
summary ... cxxxii, clxvii
Iron. (*See* Pig iron and steel.)
Iron ore, pig iron, and steel, by Ernest F. Burchard ... 291–338

Page.
Iron ore, apparent annual consumption ... 306–307
Baraboo area ... 314
Bessemer ores ... 313
bibliography ... 334–338
Cuba, shipments from ... 316–317
curve showing production of iron ore, pig iron, and steel, 1870–1913 ... 292
exports ... 315–316
imports, by countries ... 314
iron-ore industry of United States ... 293–314
Lake Superior district ... 294, 308–313
iron content of ores ... 312–313
prices ... 312
production by ranges ... 308–309
ranges ... 308
shipments, by ports ... 310–311
Mississippi Valley district ... 294
northeastern district ... 294
Pacific slope district ... 294
price per ton, by States and varieties ... 304–305, 312
principal iron-ore mines ... 301–303
production ... 293–314
by decades ... 301
by geographic districts ... 293–294
by mining districts ... 299
by States ... 294–297
by varieties ... 297–300
in principal countries ... 317–318
increase or decrease ... 297
marketed ... 293
by States ... 294–297
mined ... 293
by States ... 294–296
total ... 300–301
comparative, of iron ore, pig iron, and steel ... 292
rank of States as ore producers ... 295–296
receipts at Lake Erie ports ... 310
at Lake Michigan ports ... 311
Rocky Mountain district ... 294
southeastern district ... 294
stocks at lower lake ports ... 311–312
at mines, by States ... 304
summary ... cxxviii, clxvi–clxvii
value, by States ... 296–297
world's production ... 318
Iron Ridge area, iron ore ... 308
Italy, bauxite ... 2
copper ... 581
exports to ... 578
gold ... 849
iron ore ... 318
lead ... 728, 740
manganese ore ... 63
quicksilver ... 210
tungsten ... 361
zinc ... 647, 659

J.

Japan, chromic iron ore ... 30, 31, 38
copper ... 581
imports from ... 577
gold ... 849
iron ore ... 318
lead ... 728, 740

Page.

Japan, manganese ore 63
imports from 62
tungsten 360

K.

Kansas, cooperation ix
lead 713, 715, 718, 722, 724
silver, copper, lead, and zinc (mines report), by J. P. Dunlop 97–102
value of mineral products 1
zinc 623, 629, 632, 634
Kaolin, imports, summary ..... cxxxv, clxvii
Katanga, cobalt 339
Kentucky, iron ore 296–298, 305
lead 713, 715, 718, 722, 724
pig iron 320–321
silver, copper, lead, and zinc (mines report), by J. P. Dunlop 102–104
silver 860
value of mineral products lii
zinc 623, 629, 632, 634
Kongo, cobalt 339
palladium 450
Korea (Chosen), gold 849
iron ore 318
quicksilver exports to 211

L.

Labrador, iron ore, imports from 314
Lake Erie ports, iron ore 310–312
Lake Michigan ports, iron ore 311
Lake Superior, copper 558–561, 574
iron ore 294, 299, 308–313
iron content 312, 313
prices 312
production by ranges 308–309
ranges 308
shipments and receipts 310–311
stocks 311–312
manganiferous iron ore 65
Lead, by C. E. Siebenthal 709–745
antimonial 711, 715, 745
bibliography 745
Canadian lead bounty 742, 744
comparison of smelter and mine returns 717–720
consumption 738–740
by countries 740
content of ore, by States 722
convention 744
customs duties 735–738
desilverized 711, 745
exports, domestic 733
foreign 734
from foreign ore and base bullion 713
imports 730–733
by classes 733
by countries 733
warehouse transactions 730–731
industry, state of 709–710
as affected by war 729–730
metallurgy 726–728
concentration and separation 726
smelting 726–728
list of smelters 726–728
pigments 716
summary clxvii

Page.

Lead, prices 740–742
at New York in 1913 740–742
curves, showing weekly price 743
1850–1913 clxxiii
production 710–720
1825–1913 710–711
by States 712–713
from domestic ore 713, 745
of refined or pig 711, 745
of soft lead 711, 713–715, 745
resources, lead-producing ores 720–722
review by districts 723–725
Central States 724
Eastern States 723
Western States 725
secondary 77, 80, 716, 745
smelter and mine, State totals 720
source of lead, by ore 722
summary ..... cxxx, clxvi–clxvii
of statistics 745
tariff 735–738
trade conditions 728–744
type metal, imports 732
value 709, 742
warehouse transactions 730–731
world's consumption 740, 745
production 728, 745
Leaded zinc oxide 626
Lime, summary ..... cxxxv, clxvii–clxviii
Lithium minerals, summary cxxxvii
Lithopone 626
Lorain, Ohio, receipts of iron ore 310, 311–312
Louisiana, value of mineral products liv
Low-phosphorous iron, production 324
Luxemburg, iron-ore production 318

M.

Madagascar, iron ore 318
platinum 450
Magnesite, summary ..... cxl, clxvii
Maine, gold, silver, copper, lead, and zinc (mines report) 183
maganiferous ore 65
value of mineral products lv
zinc 623
Malay States, tin 348
Malleable pig iron 324
Manganese and manganiferous ores, by D. F. Hewett 57–74
ferromanganese 66–68, 329
imports 67–68, 330
prices 67
imports 62–63
by countries 62
by customs districts 62
notes on domestic deposits 72–73
foreign deposits 73–74
prices 59, 65, 66, 67, 71
production 59–61
by States 59–61
sources of manganese 57–59
list of principal minerals 58
spiegeleisen 66–68, 329–330
stocks 62
summary ..... cxxix, clxvi
uses 68–71
value of ores 71–72
world's production 63

Page.
Manganese and manganiferous ores, manganiferous ores 58–59, 64–65
iron ores 58
manganiferous zinc residuum 59, 66
production, by States 65
silver ores 58–59
summary cxxix
zinc residuum 66
Marble and stone, summary ..... cxxxvi, clxvii–clxiviii
Marl, summary cxxxviii
Marquette, shipment of iron ore 310
Marquette range, iron ore 308–309, 313
Maryland, cooperation ix
chromic iron ore 33
copper 533
gold 845, 854, 859
gold, silver, copper, lead, and zinc (mines report) 183
iron ore 296–298, 304, 305
pig iron 320–321
silver 845, 854, 859
value of mineral products lvii
Massachusetts, gold, silver, copper, lead, and zinc (mines report) 183
iron ore 296–298, 304, 305
pig iron 320–321
value of mineral products lix
Matawin range, iron ore 308
McCaskey, H. D., paper on gold and silver in United States 845–885
on gold, silver, copper, lead, and zinc in Eastern States (mines reports) 173–196
on quicksilver 197–212
prefatory note to the general and mines reports on gold, silver, copper, lead, and zinc in 1913 ..... clxxi–clxxiii
Menominee range, iron ore 308–309, 313
Mesabi range, iron ore 308–309, 313
Metals and metallic ores, by J. P. Dunlop 747–753
production of metals 748–750
of ores 750–753
summary cxxviii
Mexico, antimony 279
copper 581
imports from 577
gold 849
lead 713, 728
imports from 733
quicksilver 210
exports to 211
zinc ore, imports from 623, 636, 653–654
Mica, summary ..... cxli, clxvii
Michigan, cooperation ix
copper 533, 558–561
iron ore 296–298, 304, 305
manganese ore 61
pig iron 320–321
silver 845, 854, 859, 875
silver, copper, lead, and zinc (mines report), by B. S. Butler 104–114
value of mineral products lxii
Michipicoten iron range, Canada 308
Millstones and burrstones, summary ..... cxxxvii, clxvii
Milwaukee, Wis., iron-ore receipts 311
Mineral paints, summary cxxxix
Mineral production, summary of, by W. T. Thom ..... cxxvii–clxix
Page.
Mineral production, by substances ..... cxlii–cxlv
value, 1880–1913 ..... cxlvi–clxiii
Mineral products of the United States, review of conditions and output in 1912 and 1913, by Edward W. Parker ..... vii–cxxv
cooperation with State geological surveys ..... ix–x
historical review ..... xi–xiv
individual States ..... xxi–cxxv
introduction ..... vii–ix
leading States in mineral production xx
organization ..... x–xi
production and value of principal metals, fuels, and structural materials xx
rank of States in value of mineral production ..... xvi–xvii
raw and derived products ..... xiv–xxi
Mineral waters, summary ..... cxli–clxvii
Minnesota, cooperation ix
iron ore 296–298, 304, 305
pig iron 320–321
value of mineral products lxiv
Mississippi, iron ore, stocks 304
value of mineral products lxv
Mississippi Valley, iron-ore district 294
Missouri, cooperation ix
copper 533, 573
iron ore 296–298, 304, 305
lead 713, 715, 718, 722, 724
manganese ore 61
pig iron 320–321
silver 845, 854, 860, 875
silver, copper, lead, and zinc (mines report), by J. P. Dunlop 115–152
value of mineral products lxviii
zinc 623, 629, 632, 634
Molybdenum, by Frank L. Hess 341
imports 341
prices 341
summary ..... cxxxi, clxvi
Monazite and zircon, summary ..... cxli, clxviii
Montana, arsenic 283
bismuth 286
copper 533, 561–563
gold 845, 854, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report), by V. C. Heikes 583–620
iron ore 296–298, 305
lead 713, 718, 722, 725
manganese ore 61
manganiferous ore 65
silver 845, 854, 860, 868, 875, 878
value of mineral products lxx
zinc 623, 629, 632, 635

N.

Namaqualand, copper 581
Natal, chromic iron ore 36
iron ore 318
manganese ore 63
Natural gas, summary cxxxiv
Nebraska, value of mineral products lxxi
Netherlands, chromic iron ore 31
copper, exports to 575
iron ore, imports 314
manganese ore, imports 62

Page.
Nevada, copper 533, 563–566
gold 845, 854, 860–861, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report), by V. C. Heikes 803–844
iron ore 296–298, 305
lead 713, 718, 722, 725
manganese ore 61
platinum 448–450
quicksilver 197, 199, 200, 207–209
silver 845, 854, 861, 868, 875, 878
tungsten 353, 356
value of mineral products lxxiii
zinc 623, 629, 632, 635
New Brunswick, manganese ore 74
New Caledonia, chromic iron ore 30, 31, 37
cobalt 340
nickel 343
Newfoundland, copper 581
iron ore 318
imports from 314
quicksilver, exports to 211
New Hampshire, gold, silver, copper, lead, and zinc in Eastern States (mines report) 183
silver 854
value of mineral products lxxiv
zinc 629, 632
New Jersey, cooperation ix
gold, silver, copper, lead, and zinc (mines report) 183–184
iron ore 296–298, 304, 305
pig iron 320–321
value of mineral products lxxvi
zinc 623, 629, 632
residuum 66
New Mexico, cooperation x
copper 533, 566–568
gold 845, 854, 861–862, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report), by C. W. Henderson 415–439
iron ore 296–298, 305
lead 713, 718, 722, 725
manganiferous ore 65
silver 845, 854, 861, 868, 875, 878
tungsten 353, 356–357
value of mineral products lxxviii
zinc 623, 629, 632, 634
New South Wales bismuth 288
chromic iron ore 30
platinum 450
tungsten 360
New York, gold, silver, copper, lead, and zinc (mines report) 184
iron ore 296, 298, 304–305
lead ore 723
pig iron 320–321
value of mineral products lxxxii
New Zealand, manganese ore 63
platinum 448
tungsten 361
Nicaragua, quicksilver, exports to 211
Nickel, by Frank L. Hess 343–345
exports 345
imports 344
prices 345
production, sources of 343–344
blister copper 343–344
Page.
Nickel production, Canada 343
New Caledonia 343
summary ..... cxxxi, clxvi–clxvii
Nigeria, tin 347
North Carolina, aluminum 15–17
chromic iron ore 33
cooperation x
copper 533
gold 845, 854, 862, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report) 184–187
iron ore 296–298, 305
lead 713, 718, 722, 723
manganese ore 61
manganiferous ore 65
silver 845, 854, 868, 875, 878
value of mineral products lxxxiv
zinc 623, 629, 632
North Dakota, value of mineral products lxxxv
Northeastern iron district 294
Northern Territory, tungsten 360
Norway, copper 581
gold 849
iron ore 318
zinc 647
Nova Scotia, manganese ore 63, 73
tungsten 361

O.

Ocher, summary ..... cxxxix, clxiviii
Ohio, iron ore 296–298, 304, 305
pig iron 320–321
value of mineral products lxxxix
Oilstones and whetstones, summary ..... cxxxvii, clxvii
Oklahoma, cooperation x
copper 533
lead 713, 715, 718, 722, 724
manganese ore 61
silver, copper, lead, and zinc (mines report), by J. P. Dunlop 152–159
silver 854, 875, 878
value of mineral products xci
zinc 623, 629, 632, 634
Ontario, cobalt 339–340
nickel 343
platinum 448
Open-hearth steel 331, 333
Oregon, cooperation x
copper 533, 573
gold 845, 854, 862, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report), by C. G. Yale 508–522
lead 713, 718, 722, 725
platinum 445, 447
quicksilver 200, 209
silver 845, 854, 862, 868, 875, 878
value of mineral products xcii
Osmium 457
Ozokerite, summary ..... cxxxiv, clxviii

P.

Pacific slope iron district 294
Palladium 448, 457
(*See* Platinum and allied metals.)
summary ..... cxxxii, clxvii
Panama, quicksilver exports to 211

Page.

Paraffin, summary ..... cxxxiv, clxviii
Paris green and London purple..... 283
Parker, E. W., mineral products, review of conditions and output in 1912 and 1913..... vii–cxxv
Peat, summary ..... cxxxiv, clxviii
Pennsylvania chromic iron ore..... 33
  cooperation..... x
  copper..... 533, 573
  ferromanganese..... 66–67
  gold, silver, copper, lead, and zinc (mines report)..... 188
  iron ore..... 296–298, 304, 305
  manganese ore..... 61
  manganiferous ore..... 65
  pig iron..... 320–321
  silver..... 854, 859
  spiegeleisen..... 66–67
  value of mineral products..... xcvii
Peru, bismuth..... 288
  copper..... 581
    imports from..... 577
  gold..... 849
  tungsten..... 361
Petroleum, summary..... cxxxiv, clxviii
Phalen, W. C., paper on bauxite and aluminum..... 1–27
Philippine Islands, copper..... 533
  gold and silver..... 845, 854, 865
  iron ore..... 318
  quicksilver, exports to..... 211
Phosphate rock, summary..... cxxxviii, clxvii
Pig iron and steel (*see also* Iron ore, iron, and steel)..... 318–333
  blast furnaces..... 321–322
  curve showing prices of basic pig iron..... 326
  curve showing production of coke and anthracite pig iron, by months..... 323
  exports..... 327
  ferro-alloys, marketed production..... 328–330
    imports..... 329–330
  imports..... 326–327
  prices 320–321, 325–326
  production, by States..... 319–320
    according to fuel used..... 324
    blast furnaces..... 321–322
    by kinds..... 323–324
    marketed..... 320
    increase or decrease..... 320
    monthly..... 323
    total..... 325
    value..... 320
  steel production..... 330–333
    acid..... 331
    basic..... 331
    Bessemer ingots and castings..... 330–331
    crucible..... 331
    electric..... 331–332
    open-hearth ingots and castings..... 330–331
  summary cxxvii
  total..... 333
Pitchblende..... 363
Platinum and allied metals, by David T. Day..... 445–457
  allied metals..... 456–457

Page.

Platinum and allied metals, analyses.. 449–450, 451
  imports..... 450
  occurrence..... 448–456
    California..... 445
    Canada..... 448, 450
    Colombia..... 454–456
    Finland..... 448
    Germany..... 456
    Nevada..... 448–450
    New Zealand..... 448
    Oregon..... 445
    Russia..... 451–454
    Sumatra..... 448
    Wyoming..... 448
  prices..... 446–447
  production, domestic, crude..... 445
    refined..... 446
    from sands..... 445
    from gold and copper bullion..... 446
  summary ..... cxxxii, clxvi
  uses..... 456
  world's production..... 450
Poland, zinc..... 647
Porto Rico, gold and silver..... 846, 854
Portugal, chromic iron ore..... 31
  copper..... 581
  gold..... 849
  iron ore..... 318
  tungsten..... 361
Portuguese India, manganese ore..... 63
Potassium salts, summary..... cxxxviii, clxvii
Prefatory note, by H. D. McCaskey.. clxxi–clxxiii
Prices, aluminum..... 17–18
  antimony..... 281
  bauxite..... 1
  bismuth..... 288
  cadmium..... 671
  chromic iron ore..... 30
  cobalt..... 340
  copper..... 580
    1850–1913..... clxxiii
  ferro-alloys..... 329, 341, 351, 357
  ferromanganese..... 67
  iron ore..... 304–305, 312
    Lake Superior..... 312
  lead..... 740–742
    1850–1913..... clxxiii
  manganese ore..... 59, 71
  manganiferous ore..... 65
  manganiferous zinc residuum..... 66
  molybdenum..... 341
  nickel..... 345
  pig iron..... 321
  platinum..... 446–447
  quicksilver..... 212
  selenium..... 289
  silico-spiegel..... 67
  silver..... 847
    1850–1913..... clxxiii
  spiegeleisen..... 67
  tin..... 348
  tungsten..... 357
  zinc..... 660–661
    1850–1913..... clxxiii
    dust..... 660

Page.

Principal iron-ore mines 301-303
Pumice, summary ..... cxxxvii, clxviii
Pyrite, summary ..... cxxxviii, clxviii

Q.

Quartz, summary cxli
Queensland, bismuth 288
molybdenum 341
tungsten 360
Quicksilver, by H. D. McCaskey 197-212
bibliography 212
condition of industry 197-198
deposits, ores, and gangues 201-202
exports 211
imports 210-211
prices 212
production 199-202
by States 199-200
for period 1902-1913 200
number of mines, metal output, and value 199
resources, occurrences, and development, by States 202-210
Alaska 210
Arizona 202
California 202-207
Idaho 207
Nevada 207-209
Oregon 209
Texas 209
Utah 210
Washington 210
summary ..... cxxx, clxvii
tariff 210
tonnage and recovery 200-201
uses 198-199
world's production 210

R.

Radium, uranium, and vanadium, by Frank L. Hess 363-364
Colorado 363-364
exports 364
imports 364
production 364
South Carolina 363
Utah 363-364
Rhode Island, value of mineral products xcviii
Rhodesia, chromic iron ore 30, 36
Rocky Mountain iron-ore district 294
Russia, chromic iron ore 30, 38
copper 581
exports to 578
gold 849
iron ore 318
imports from 314
lead 728, 740
manganese ore 57, 63
imports from 62
platinum 448, 450, 451, 454
analysis of 451
quicksilver 210
zinc 623, 659
secondary 647
Rutile, summary cxxxi
(*See also* Titanium.)

S.

Page.

Salicylic acid, summary clxviii
Salt, summary ..... cxxxviii, clxviii
Salvador, quicksilver, exports to 211
Sand and gravel, summary ..... cxxxv, clxviii
Sand-lime brick, summary cxxxvi
Sandusky, Ohio, receipts of iron ore ... 310, 311-312
Santo Domingo (Dominican Republic), quicksilver exports to 211
Saxony, bismuth 288
Secondary metals, by J. P. Dunlop 75-80
aluminum 80
antimony 78, 80
brass, remelted 80
copper 77-80
introduction 75-77
lead 77-78, 80
recovery 80
tin 79-80
zinc 78, 80
Selenium and tellurium, by Frank Hess 289
prices 289
production 289
summary cxxxii
Serpek process of producing alumina 11-12
Servia, copper 581
gold 849
Siam, gold 849
tungsten 360
Siberia, zinc 623
Siebenthal, C. E., paper on cadmium 669-671
on lead 709-745
on zinc 621-667
Sienna and umber, summary ..... cxxxix, clxviii
Silesia, cadmium 670
Silica, summary cxli
Silico-spiegel, price 67
Silver (*see* Gold and silver) 845-885
Silver, copper, lead, and zinc in the Central States (mines reports), by B. S. Butler and J. P. Dunlop 81-171
introduction, by J. P. Dunlop 81
lead and zinc, production, by regions 85-86
production 83-85
publications 170-171
summary of production 85
tenor of lead and zinc ores 82-83
Arkansas, by J. P. Dunlop 86-90
Illinois, by J. P. Dunlop 90-95
Iowa, by J. P. Dunlop 95-96
Kansas, by J. P. Dunlop 97-102
Kentucky, by J. P. Dunlop 102-104
Michigan, by B. S. Butler 104-114
Missouri, by J. P. Dunlop 115-152
Oklahoma, by J. P. Dunlop 152-159
Wisconsin, by J. P. Dunlop 160-170
Singkep, tungsten 361
Slate, summary ..... cxxxvi, clxviii
Soapstone, summary cxli
Sodium nitrate, summary ..... cxxxviii, clxvii
South Africa, chromic iron ore 36
tin 347
tungsten 360
South America, lead 713
imports from 733
South Carolina, gold 845, 854, 862, 868, 872, 878

Page.
South Carolina, gold, silver, copper, lead, and zinc (mines report) 188–189
manganese ore 58–61
manganiferous ore 65
pitchblende 363
silver 845, 854, 868, 875
tin 347
value of mineral products c
South Chicago, Ill., iron-ore receipts 311
South Dakota, copper 533
gold 845, 854, 862, 868, 872, 878
gold, silver, copper, and lead (mines report), by C. W. Henderson 41–49
lead 713, 718, 722
manganese ore 61
silver 845, 854, 862, 868, 875, 878
tin 347
tungsten 353, 357
value of mineral products ci
Southeastern iron-ore district 294
Spain, bismuth 288
copper 581
imports from 577
gold 849
iron ore 318
imports from 314
lead 728
manganese ore 63
quicksilver 210
tungsten 361
zinc 647, 659
Spiegeleisen, imports 67–68, 330
prices 67
production 67, 324, 329
summary ..... cxxix, clxvi
(*See also* Manganese ore.)
Spring Valley area, iron ore 308
Steel 330–333
(*See* Pig iron and steel.)
Stone, summary ..... cxxxvi, clxvii–clxviii
Straits Settlements, tin 348
Strontium, summary ..... cxxxix, clxviii
Sudbury, Canada, nickel 343–344
Sublimed blue and white lead 716
Sulphur, summary ..... cxxxviii, clxviii
Sulphuric acid from smelters, summary cxxxviii
Sumatra, platinum 448, 450
Summary of mineral production, compiled by W. T. Thom ..... cxxvii–clxix
curve showing value of mineral products, 1880–1913 clxv
exports ..... clxvii–clxviii
general remarks cxxvii
abrasive materials ..... cxxxvi–cxxxvii
chemical materials ..... cxxxvii–cxxxix
fuels ..... cxxxiii–cxxxiv
imports ..... clxvi–clxix
metals and ores ..... cxxviii–cxxxii
miscellaneous ..... cxxxix–cxlii
pigments cxxxix
structural materials ..... cxxxiv–cxxxvi
table of mineral products, 1912–13 ..... cxliii–cxlv
from 1880 to 1913 ..... clxvi–clxiii
value of, from 1880 to 1913 ..... clxiv–clxv
Superior, shipments of iron ore 310
Page.
Sweden, chromic iron ore 30
copper 581
gold 849
iron ore 318
imports from 314
lead 728
manganese ore 63
Switzerland, lead 740

T.

Talc and soapstone, summary ..... cxli, clxviii
Tantalum, summary cxxxii
Tariff, lead 735–738
quicksilver 210
zinc 657–658
Tasmania, bismuth 288
copper, imports from 577
platinum 450
tungsten 361
Tellurium 289
summary cxxxii
Tennessee, aluminum 16–17
bauxite 1–2, 3–7
copper 533, 568–569
gold 845, 854, 862, 868, 872
gold, silver, copper, lead, and zinc (mines report) 189–192
iron ore 296–298, 304, 305
lead 713, 715, 723
manganese ore 61
manganiferous ore 65
pig iron 320–321
silver 845, 854, 863, 868, 875
value of mineral products civ
zinc 623, 629, 632, 633
Texas, cooperation x
copper 533
gold 845, 854, 863, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report), by C. W. Henderson 440–443
iron ore 296–298, 304, 305
lead 713, 718, 722, 725
quicksilver 197, 199, 200–201, 209
silver 845, 854, 863, 868, 875, 878
value of mineral products cvii
zinc 623, 629, 632, 634
Thom, W. T., compilation of summary of mineral production of the United States in 1913 ..... cxxvii–clxix
Thorium nitrate, summary ..... cxli, clxviii
oxide, summary clxviii
Tin, by Frank L. Hess 347–349
Alaska 347
deliveries 347
imports 349
prices 348
production 347
secondary 79–80
summary ..... cxxxii, clxvii
world's supply 347
Titanium, by Frank L. Hess 351
imports 330
prices 351
production 351
summary (rutile) ..... cxxxi, clxvi

Page.
Toledo, Ohio, receipts of iron ore..... 310,311-312
Transvaal, chromic iron ore..... 36
Tripoli, summary ..... cxxxvi, clxvii
Tungsten, by Frank L. Hess..... 353-361
analysis..... 354
Burma..... 357,360
general conditions..... 353
imports..... 330
market..... 357
prices..... 357,359
production..... 359,360
resources..... 357
summary..... cxxxi, clxvii
uses..... 358
world's production..... 360-361
Tunis, iron ore..... 318
Turkey, chromic iron ore..... 30,31,33,36-37
copper..... 581
gold..... 849
lead..... 728
manganese ore..... 63
Two Harbors, Minn., shipments of iron ore.. 310
Type metal, imports ..... 732, clxvii

U.

United Kingdom, bauxite..... 2
copper, exports to..... 578
imports from..... 577
iron ore..... 318
imports from..... 314
lead, imports from..... 733
manganese ore..... 63
imports from..... 62
quicksilver, exports to..... 211
Uranium and vanadium..... 363-364
(*See also* Radium, uranium, and vanadium.)
summary..... cxxxi, clxvii
Uruguay, gold..... 849
Utah, arsenic..... 283
copper..... 533, 569-572
gold..... 845, 854, 863-864, 868, 872, 878
gold, silver, copper, lead, and zinc (mines report), by V. C. Heikes..... 365-413
iron ore..... 296-298, 304, 305
lead..... 713, 718, 722, 725
manganese ore..... 61, 73
quicksilver..... 199, 200, 210
radium..... 363-364
selenium..... 289
silver..... 845, 854, 864, 868, 875, 878
uranium..... 363-364
value of mineral products..... cx
vanadium..... 363-364
zinc..... 623, 629, 632, 635

V.

Value of mineral products, by substances, in 1912-1913..... cxlii-cxlv
from 1880 to 1913..... cxlvi-clxiii
total, 1880-1913 ..... clxiv-clxv
Vanadium (*see also* Radium, uranium, and vanadium)..... 363-364
Venetian red, summary..... clxviii
Venezuela, copper..... 581
gold..... 849
quicksilver, exports to..... 211
Vermilion range, iron ore..... 308-309, 313
Vermont, gold, silver, copper, lead, and zinc (mines report)..... 192
copper..... 533
gold..... 854, 868, 872
manganese ore..... 61
manganiferous ore..... 65
silver..... 845, 854, 868, 875
value of mineral products..... cxii
Victoria, manganese ore..... 73
tungsten..... 361
Virginia, cooperation..... x
copper..... 533, 573
gold..... 845, 854, 862, 868, 872
gold, silver, copper, lead, and zinc (mines report)..... 192-194
iron ore..... 296-298, 304, 305
lead..... 713, 715, 718, 722, 723
manganese ore..... 58-61
manganiferous ore..... 65
pig iron..... 320-321
silver..... 845, 854, 868, 875
titanium (rutile)..... 351
value of mineral products..... cxvi
zinc..... 623, 629, 632, 633

W.

Washington, cooperation..... x
copper..... 533, 573
gold..... 845, 854, 864, 868, 872, 878
gold, silver, copper, and lead (mines report), by C. N. Gerry..... 789-801
lead..... 713, 715, 718, 722, 725
quicksilver..... 199, 210
silver..... 845, 854, 864, 868, 875, 878
tungsten..... 353, 357
value of mineral products..... cxix
zinc..... 623
West Virginia, iron ore..... 296-298, 304, 305
manganese ore..... 61
pig iron..... 320-321
value of mineral products..... cxxii
Western Australia, tungsten..... 361
Whetstones, summary..... cxxxvii
Wisconsin, cooperation..... x
iron ore..... 296-298, 304, 305
lead..... 713, 715, 718, 722, 724
pig iron..... 320-321
silver, copper, lead, and zinc (mines report), by J. P. Dunlop..... 160-170
value of mineral products..... cxxiv
zinc..... 623, 629, 632, 633
World's production, bauxite..... 2
chromic iron ore..... 30
copper..... 581
gold..... 847-849
iron ore..... 318
lead..... 728, 745
manganese ore..... 63
pig iron..... 328
platinum..... 450
quicksilver..... 210

Page.

World's production, tin ... 347
tungsten ... 360–361
zinc ... 646–647
Wyoming, chromic iron ore ... 29, 33
copper ... 533
gold ... 845, 854, 865, 868, 872, 878
gold, silver, and copper (mines report), by C. W. Henderson ... 49–55
iron ore ... 296–298, 305
silver ... 845, 854, 865, 868, 875, 878
value of mineral products ... cxxv

Y.

Yale, Charles G., paper on gold, silver, copper, lead, and zinc in California (mines report) ... 459–507
Oregon (mines report) ... 508–522

Z.

Zinc, by C. E. Siebenthal ... 621–667
bibliography ... 664–667
brass, old, imports ... 654
remelted ... 80
comparison of smelter and mine returns 628–630
condition of industry ... 622
as affected by the war ... 647–651
consumption ... 658–660
in United States ... 659–660
world's ... 659–660
content of ore ... 632
convention ... 663
customs duties ... 657–658
districts, zinc producing ... 632–636
Central States ... 633–634
Eastern States ... 632–633
Western States ... 634–636
dross, exports of ... 655
dust ... 625–626, 653, 660
exports, domestic ... 655
foreign ... 656
imports ... 651–654
lithopone ... 626
metallurgy ... 639–646
concentration ... 639–642
flotation ... 639–642
smelting ... 642–643
chemical ... 642

Page.

Zinc, metallurgy, smelting, electrochemical ... 642–643
electrothermic ... 643
smelters ... 643–646
changes ... 645–646
list of ... 644
new oxide plant ... 646
mine and smelter totals ... 630–631
ore, imports from Canada and Mexico ... 653–654
oxide ... 626, 654–655
exports ... 626, 655
leaded zinc ... 626
zinc-lead ... 626
imports ... 626, 654
summary ... cxxxix, clxviii
pigments ... 626
prices ... 660–661
at St. Louis in 1913 ... 660–661
curves ... 662–663
1850–1913 ... clxxiii
production ... 622–631
annual, 1873–1913 ... 622–623
by location of smelter ... 624
by six-month periods ... 625
by States ... 623–625
residues ... 713
residuum ... 59, 66
resources ... 631–638
mine production ... 631–632
Australia ... 636–638
Canada ... 636
Mexico ... 636
United States ... 631–636
secondary zinc ... 78, 80, 627–628
production in Europe ... 647
smelter and mine totals ... 630–631
summary ... cxxx, clxvii
of statistics ... 664
tariff ... 657–658
trade conditions ... 646–664
value ... 622, 661
warehouse transactions ... 651–652
world's consumption, by countries ... 659–660
production, by countries ... 646–647
Zinc-lead ... 626
Zinc oxide ... 626, 654–655
(*See also* Zinc.)
Zinc residuum, manganiferous ... 59, 66
summary ... cxxxix, clxvii
Zircon, summary ... cxli